PhET Interactive Simulations: Engaging students and supporting learning

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Goals

Become familiar with PhET:

When, how, and why might you use a PhET sim?

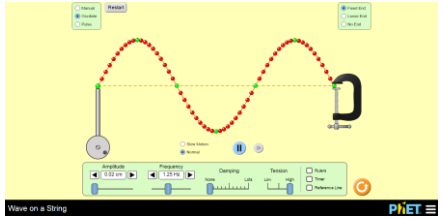
Explore different ways to use simulations in teaching

Use research findings around simulations to guide that use in class

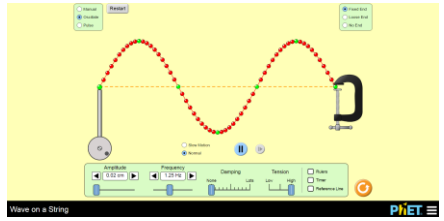
Look forward at the frontier of simulations in education

PhET Overview

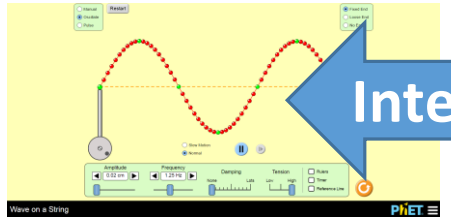
Product Development



Research



Classroom



Integration

Teacher

Student ⟷ Student

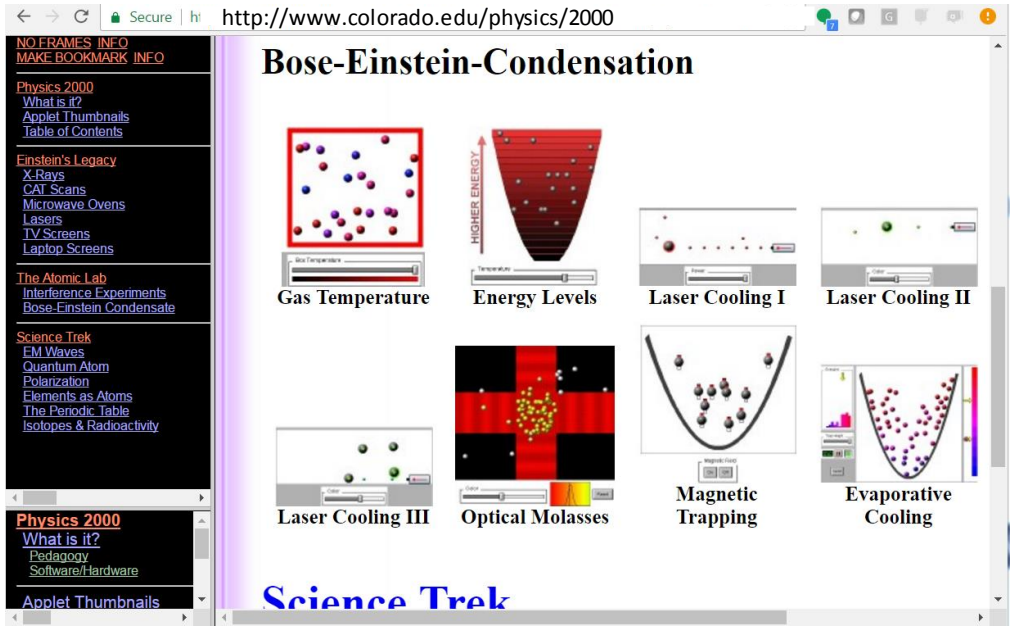
PhET Overview

Founded in 2002 by Carl Wieman

(Originally Physics Education Technology project)

Nobel Prize in Physics

Physics 2000 (Marty Goldman, PI)



PhET Overview

PhET Interactive Simulations

140+ simulations & 1600+ sim-based lessons

Physics, Chemistry, Math, Earth Science, Biology

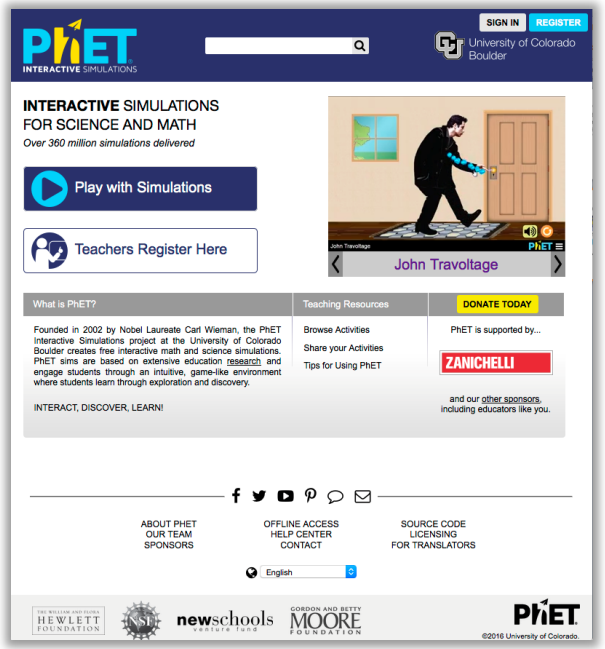
Research-based and user-tested

K-12 and College

Open education resources (free)

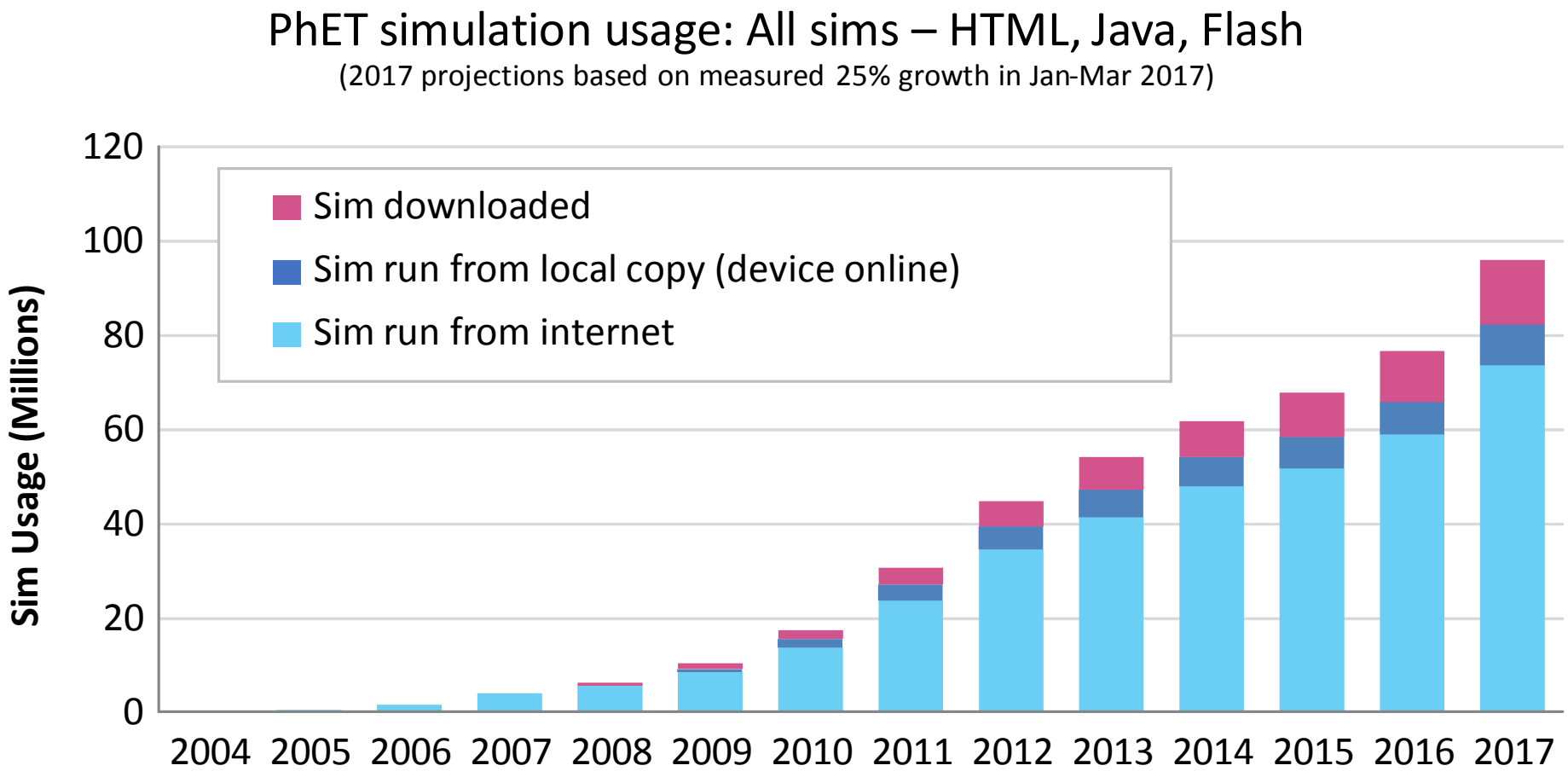
Java, Flash, **and HTML**

Run online or offline



PhET Overview

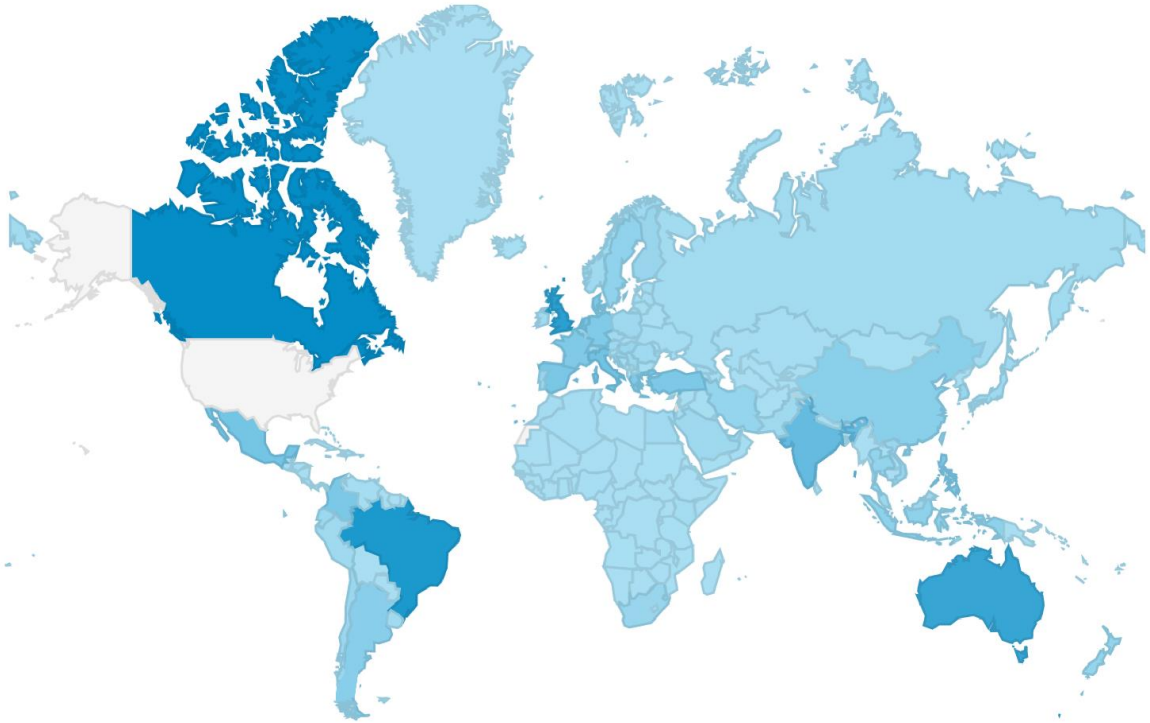
Over 80 Million Uses/Year

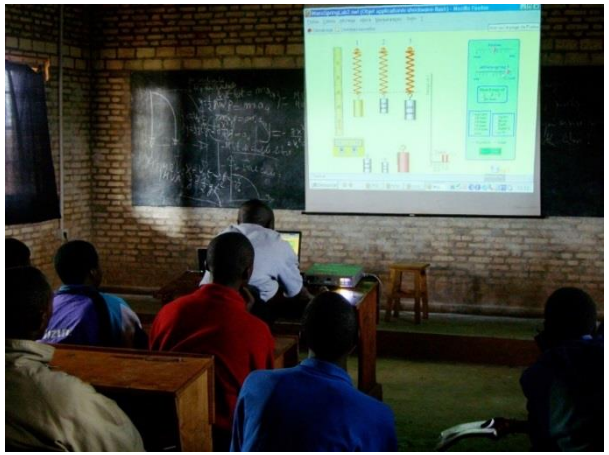


PhET Overview

Global

~33% International. In 90 languages.

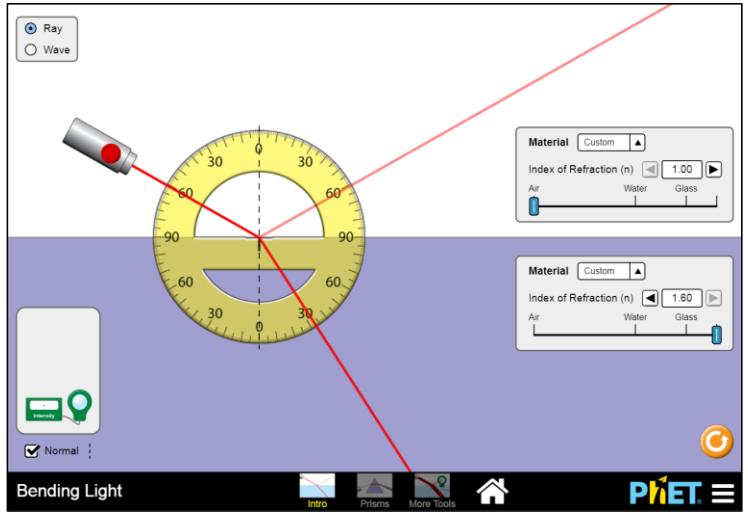


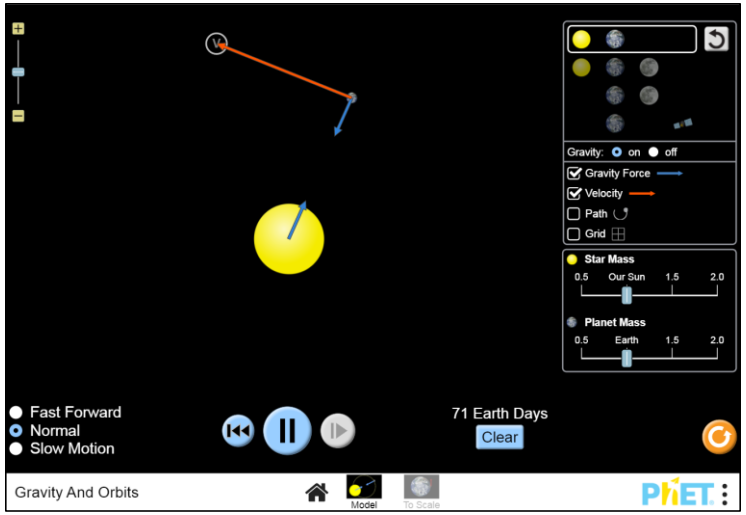


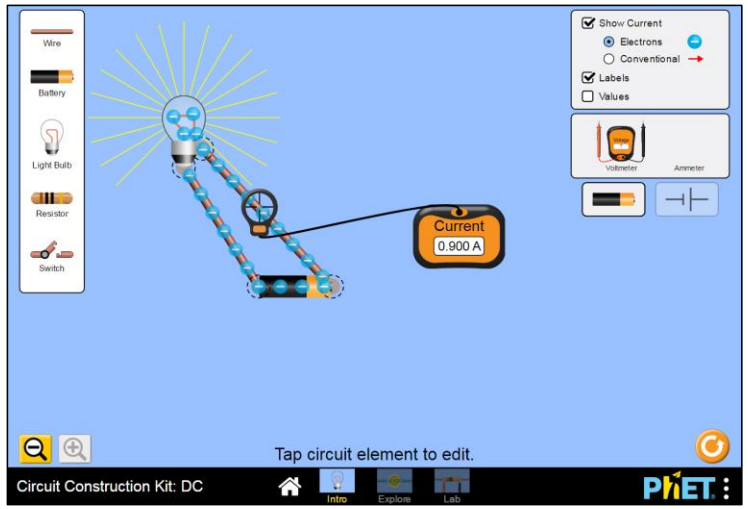
BURUNDI

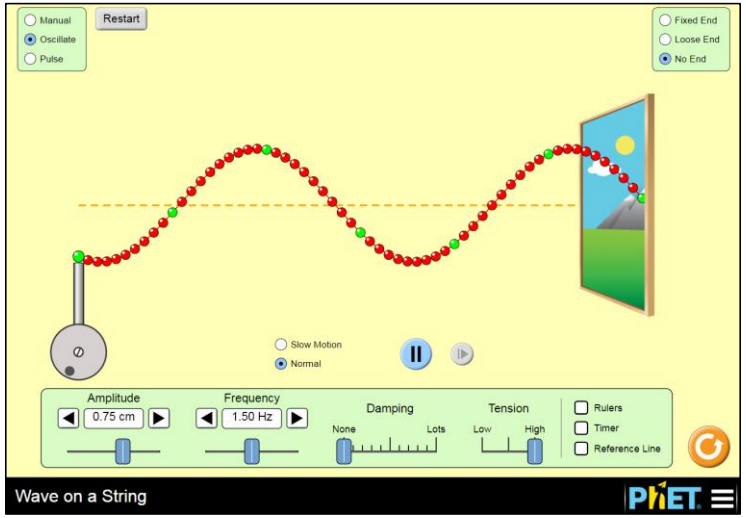
Sim Tour

Examples





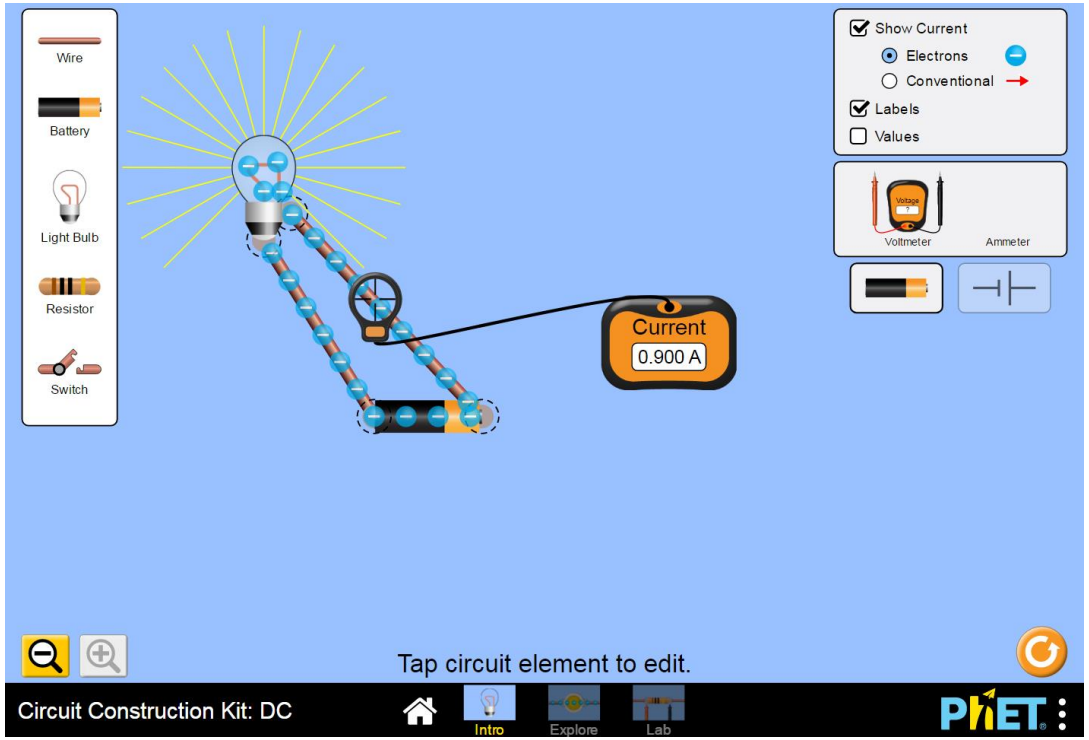




PhET

Sim Design

Implicit Scaffolding



HIGHLY INTERACTIVE

IMMEDIATE DYNAMIC FEEDBACK

REAL WORLD CONNECTIONS

ACCURATE, DYNAMIC VISUAL MODELS & REPRESENTAIONS

SHOWS THE INVISIBLE

SCAFFOLDED THROUGH DESIGN

ALLOWS ACTIONS NOT POSSIBLE IN THE REAL WORLD

INTUITIVE INTERFACE

Adams et al. (2008a), J. Interactive Learning Research
Adams et al. (2008b), J. Interactive Learning Research

Sim Design

Support Multiple Learning Goals

CONTENT: Concepts, Models, Representations, Relationships

PROCESS: Explore, Question, Design, Predict, Data, Evidence, Reason

SOFT SKILLS: Argumentation, Collaboration, Planning, Reflection
HARD SKILLS: Lab techniques, Quantitative problem solving

AFFECTIVE: Enjoyable, Understandable, Relevant, Student Agency

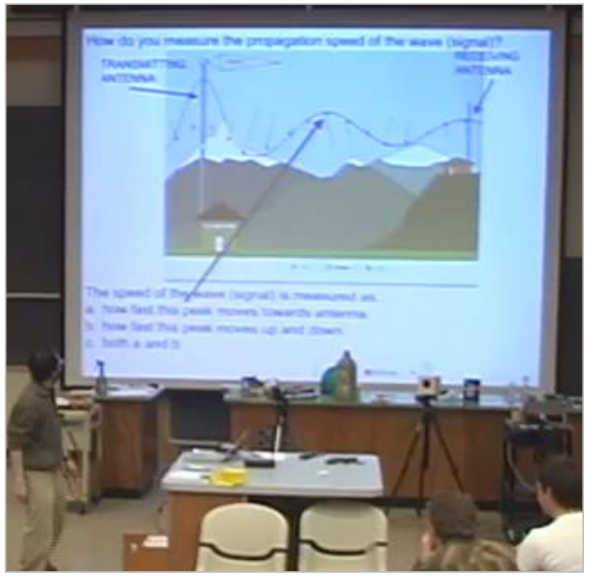
Sim-based Learning

How might you use these sims in your school?

Sim-based Learning

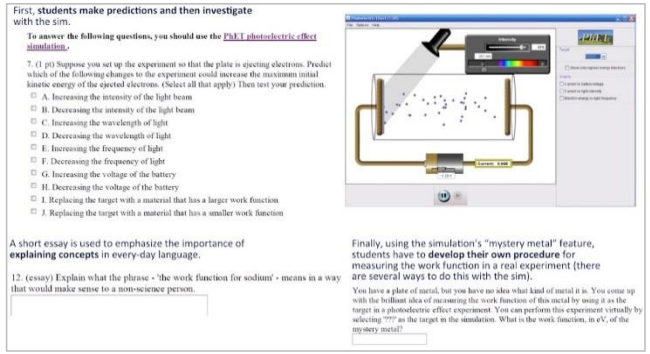
Versatile tool for teaching and learning

Interactive Lecture



Lecture Tutorial

Activity/ Lab



Pre-lab/ Pre-class/ Homework

PhET

Sim-based Learning

Engaging Students in Lecture

Lecture Demonstration / Visualization

Coupled with Concept Tests and Peer Instruction

Interactive Lecture Demos

Interactive Discussion with Predications

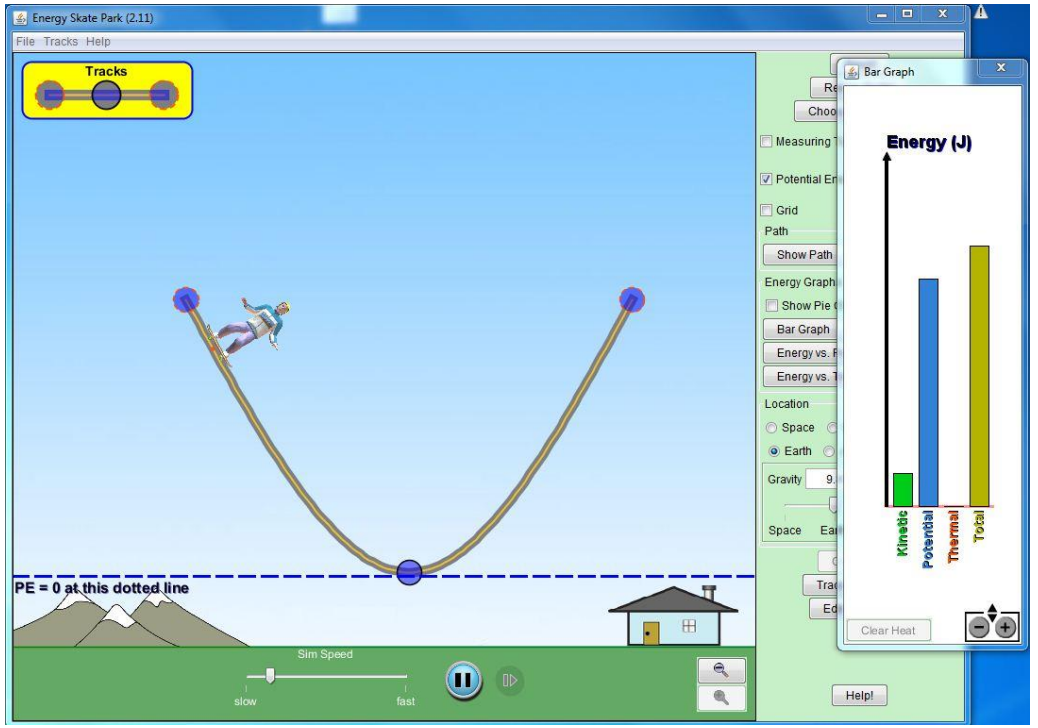
Whole Class Inquiry (student-suggested experiments)

See Teaching Resources for helpful videos:

http://phet.colorado.edu/en/teaching-resources/usingPhetInLecture

Sim-based Learning

Concept Questions



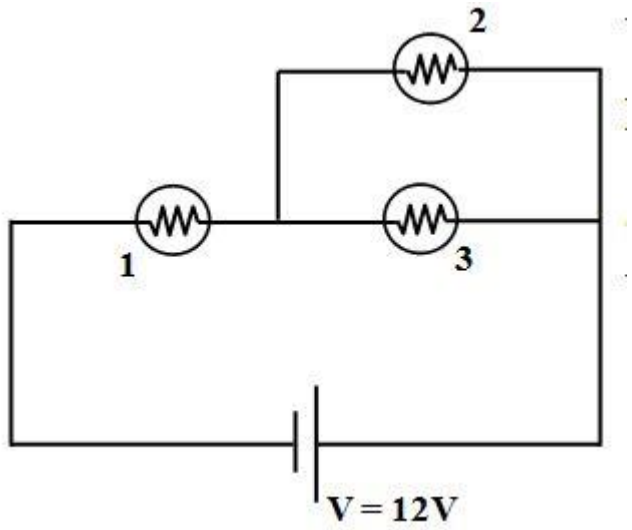
I move the zero of PE up to the starting point of the Skateboarder (skateboarder still starts from rest).

The total energy of the system is now:

A) Zero
B) Positive
C) Negative
D) Depends on the position of the skateboarder

Sim-based Learning

Concept Questions

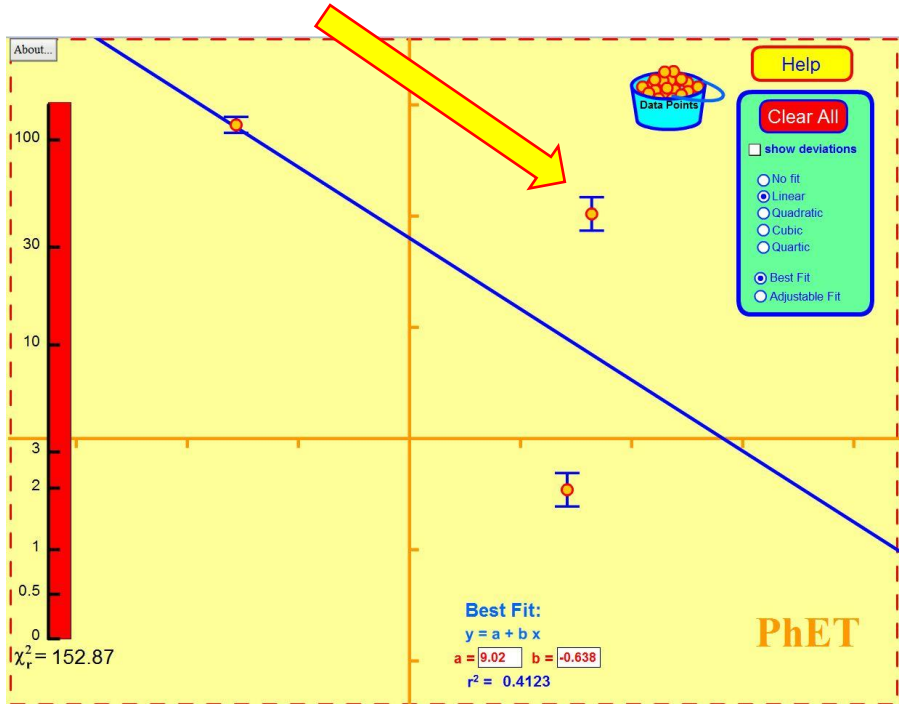


What happens to the brightness of bulb 1, when bulb 2 burns out?
(When a bulb burns out, its resistance becomes infinite.)

A) Bulb 1 gets brighter
B) Bulb 1 gets dimmer.
C) Its brightness remains the same.

Sim-based Learning

Concept Questions

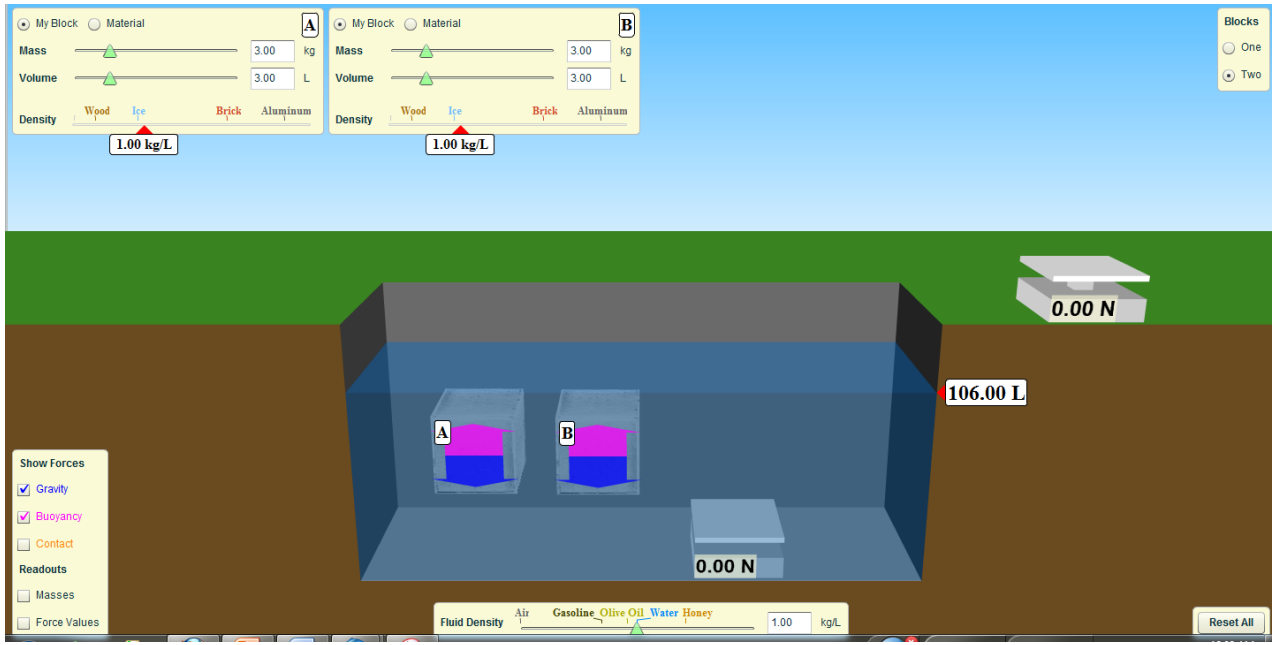


If we increase the error bar on the date point shown, what happens to the slope of the best-fit line?

A) It becomes more negative (line tilts CW).
B) It becomes less negative (line tilts CCW).
C) It does not change.

Sim-based Learning

Whole Class Inquiry



What change would make these blocks float?
And why?
(How many strategies can you find!)

A look inside the classroom

Concept test & Follow-up discussion

Is there a force of friction acting on my laptop which is sitting stationary on the table?

A) Yes
B) No
C) Not sure

A look inside the classroom

Follow-up discussion

Sim-based Learning

Instructor versus Student Control

Opportunity for students to engage in and think about exploration, experimentation, design, evidence

Science

Curiosity

Experimentation

Interpretation

Data

Predict

Inquiry

Explanation

Analysis

Evidence

Test

Limits

Reasoning

Assumptions

Models

Mechanism

Uncertainty

Representations

Science Learning

Science learning often far from science practice

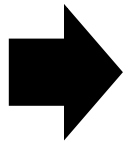
In lab:
Specific
Procedures

In class:
Content
Knowledge

The Challenge

Learning science through science inquiry

Science Inquiry
Scientific Practices
Problem Solving

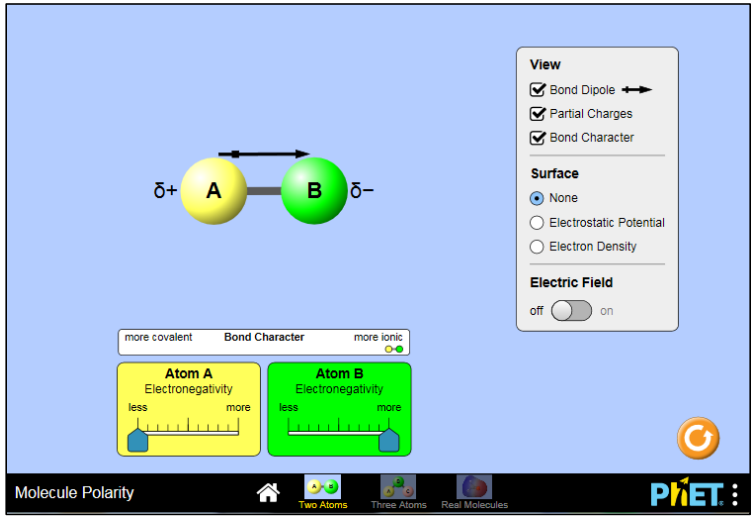


Advance (their) understanding, knowledge, and ideas

A look inside the classroom

Wrap up of Molecule Geometry Topic **20 min.**	Sim Exploration **10 min.**	Guided-Inquiry Activity with Sim **25 min.**

Molecule Polarity Sim

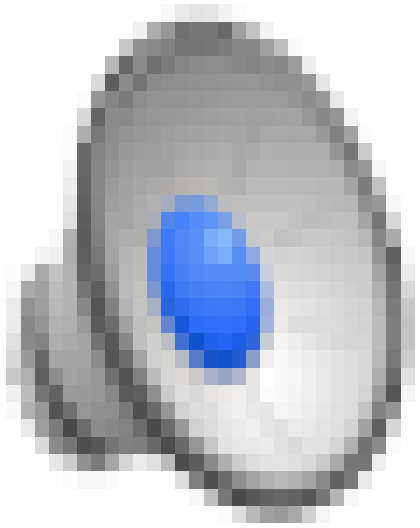


80 Students

Moore et al. Chemistry Education Research and Practice, 14(3), 257-268, 2013.

A look inside the classroom

Initial Exploration (first 2:20)



Moore et al. Chemistry Education Research and Practice, 14(3), 257-268, 2013.

A look inside the classroom

Science Practices Observed

Messing around

Sensemaking

Experimentation

Reasoning

Identifying Relationships

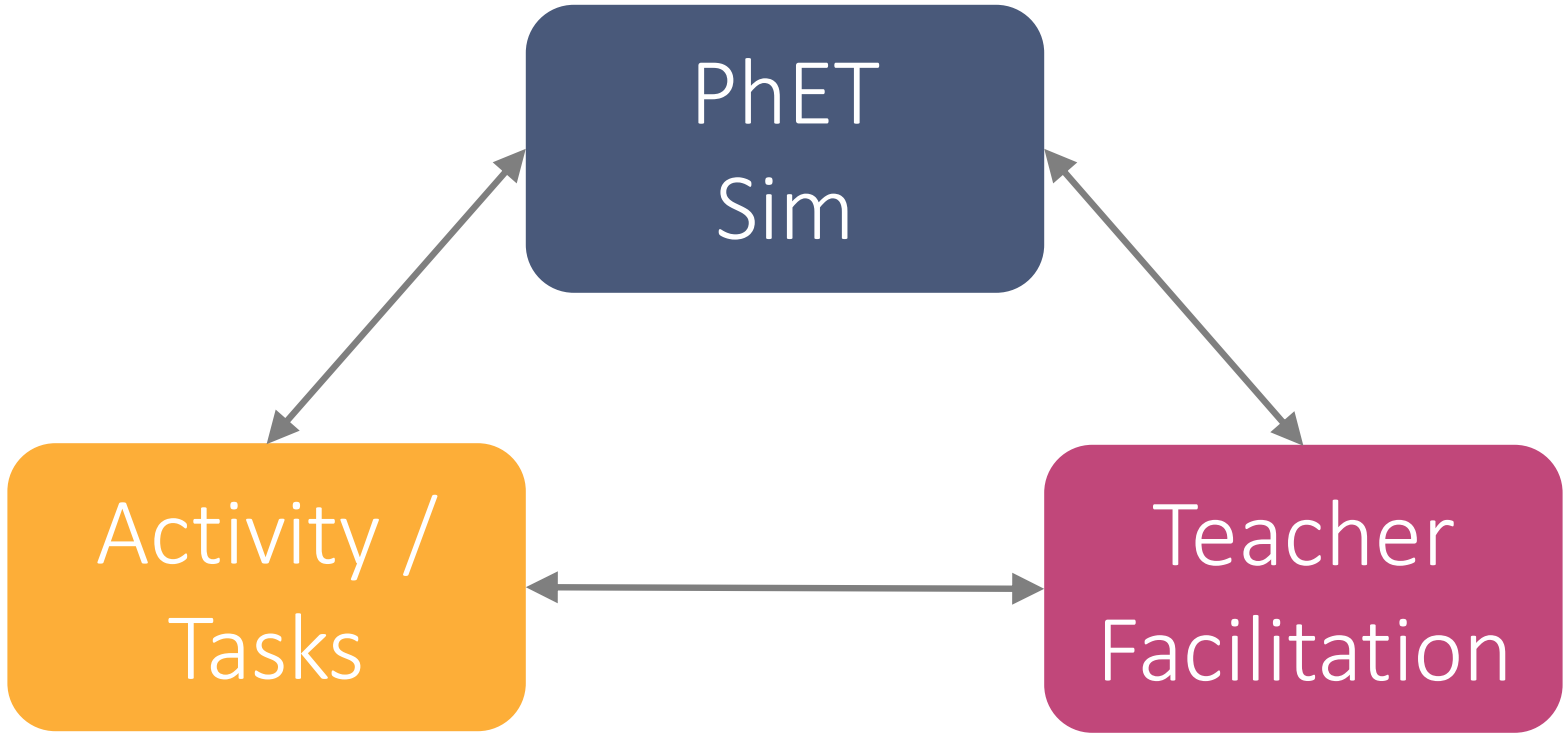
Testing

Predication

Asking Questions

Sim-based Learning

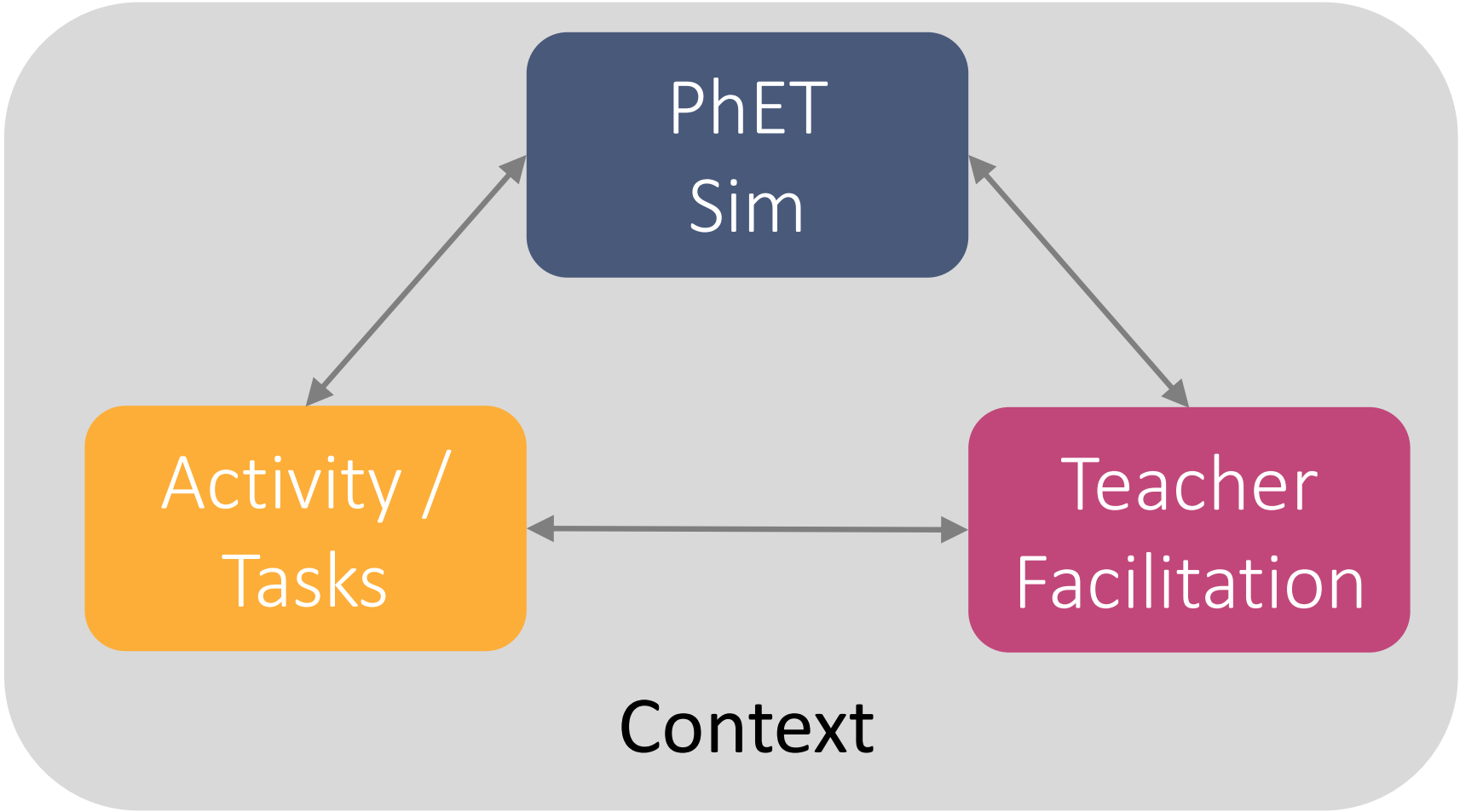
Creating Sim-based Learning Environments



Distributed Scaffolding

Sim-based Learning

Creating Sim-based Learning Environments



Sim-based Learning

Strategies for designing sim-based activities

Start with open play

Avoid explicit instruction

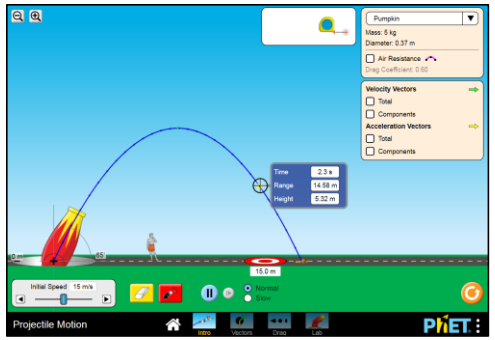
Leverage affordances of the sim

Use open, investigative questions and **challenge prompts**

More at: https://phet.colorado.edu/en/teaching-resources/tipsForUsingPhet

Sim-based Learning

Strategy: Use Challenge Prompts



Not this

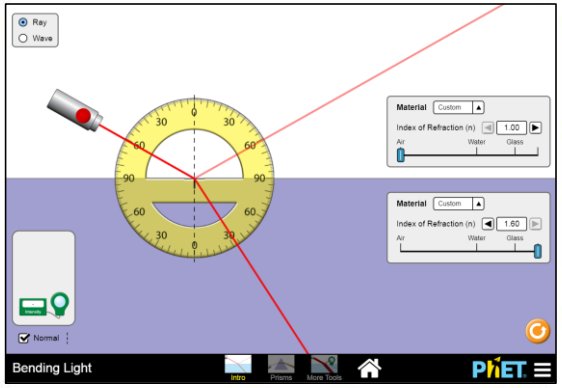
Set the canon angle to 45 degrees …

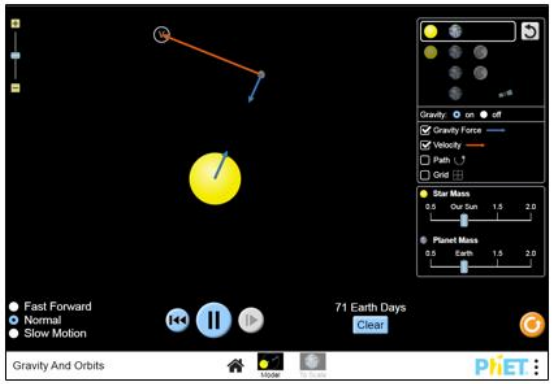
This

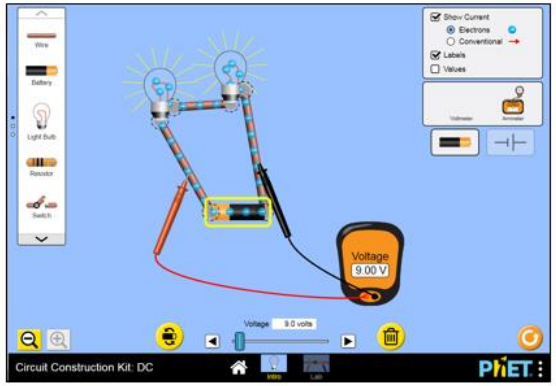
What are all the ways to affect projectile distance?

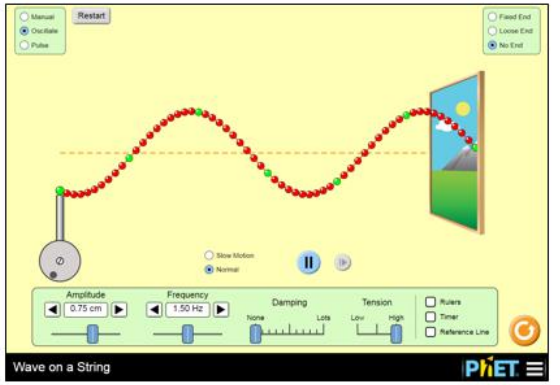
Mini design task

Pick one sim and write a challenge prompt

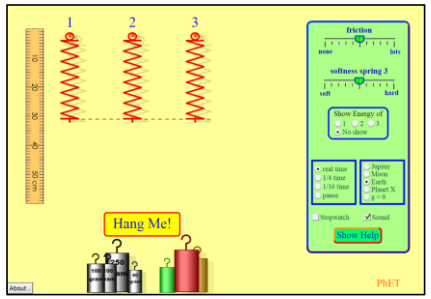


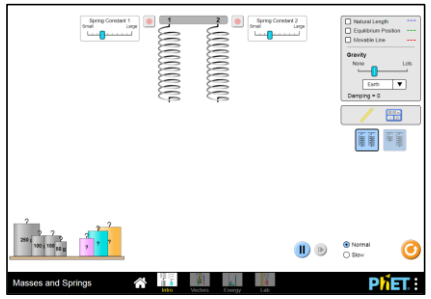






Example Activity





Masses and Springs

5-10 minutes of play – No instructions.

Challenge 1: Using data from the sim, make a graph that shows whether or not the springs obey Hooke's Law.

Challenge 2: What is the mass of the red weight?

Challenge 3: Determine the spring constant in two different ways: with your graph from (1) and with the stopwatch.

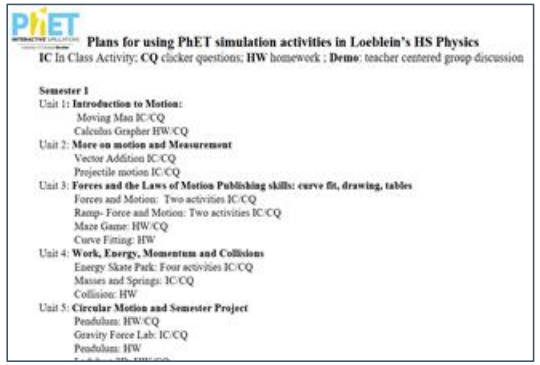
Sim-based Learning

Activity Design and Facilitation Resources

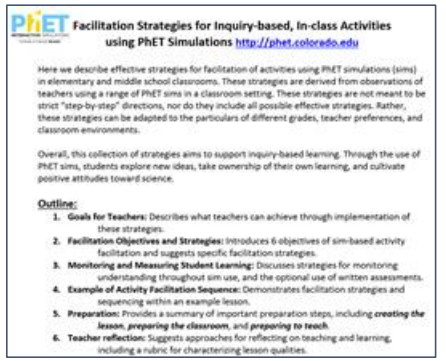
Video Series

Activity Writing Guide

Course Alignment Documents



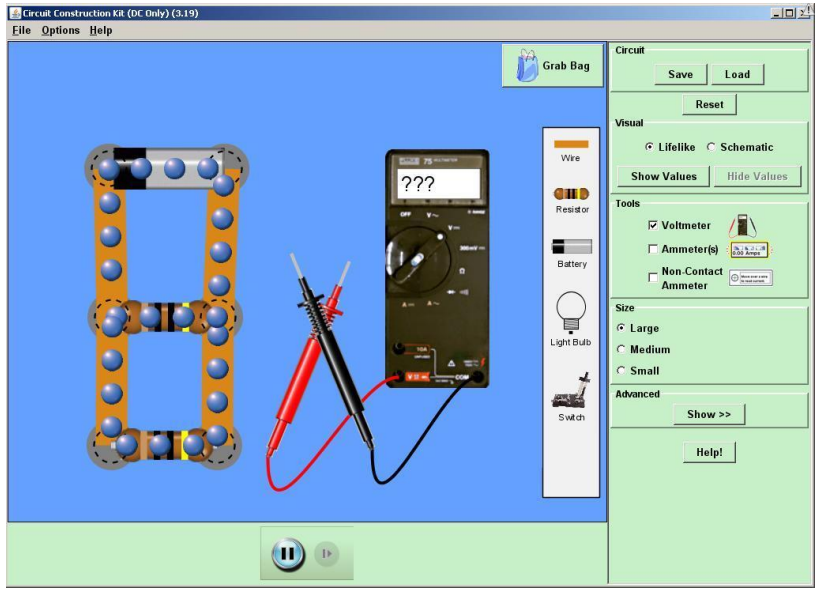
Facilitation Guide



https://phet.colorado.edu/en/teaching-resources

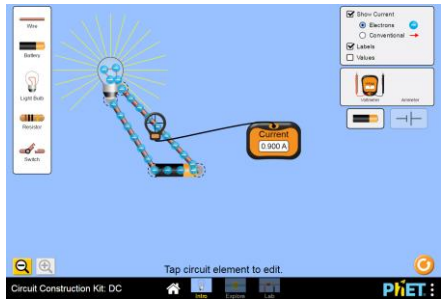
Sim-based Learning

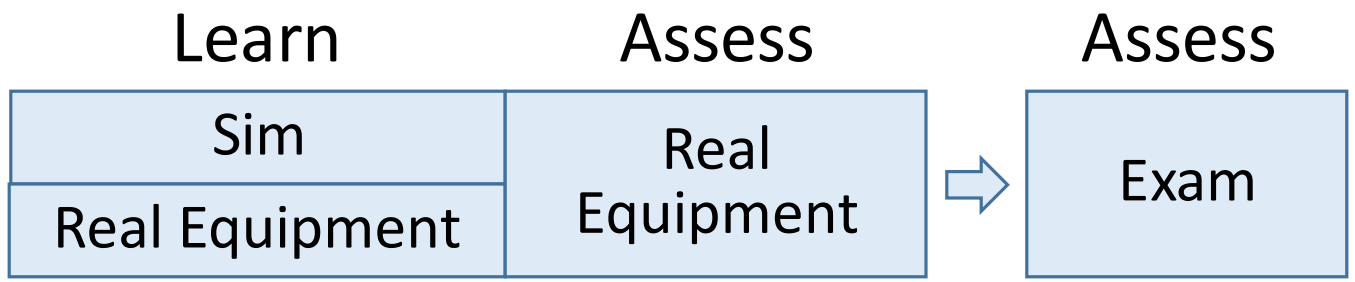
Compare and Contrast

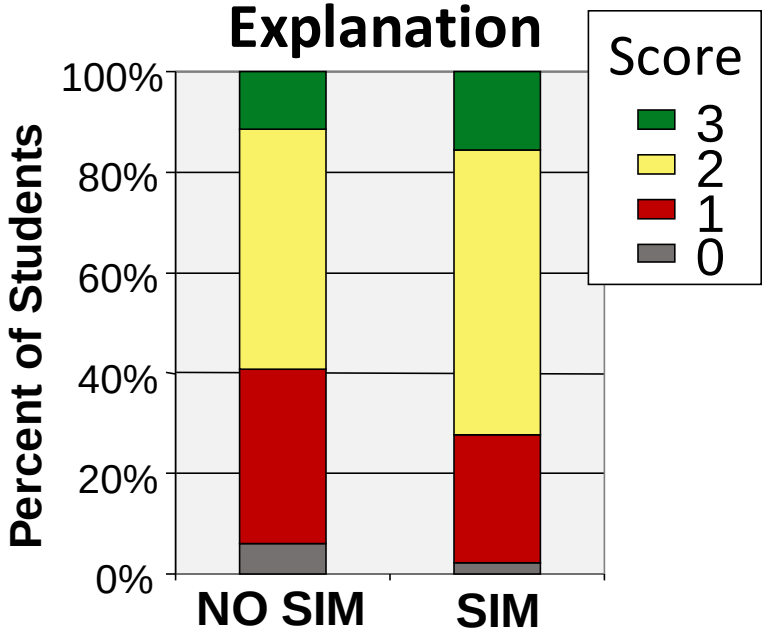


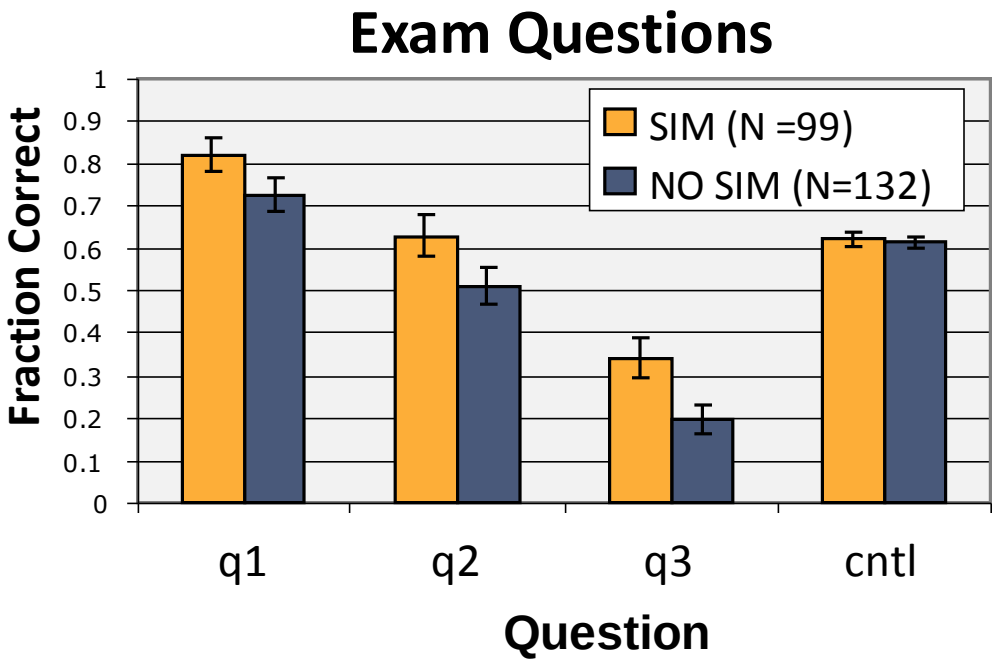
Sim-based Learning

Impact on learning









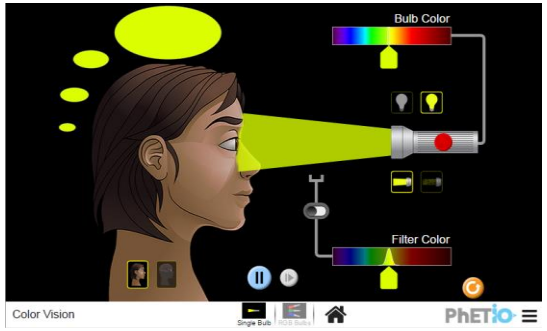
Frontiers: PhET-iO

PhET-iO Simulations

Customizable and Interoperable with Back-end data

PhET-iO

INTERACTIVE SIMULATIONS WITH INTEROPERABLE FEATURES



Embed

API

Data

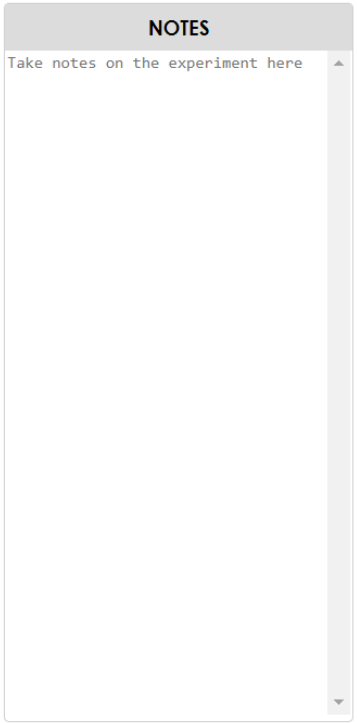
Any Educational Technology

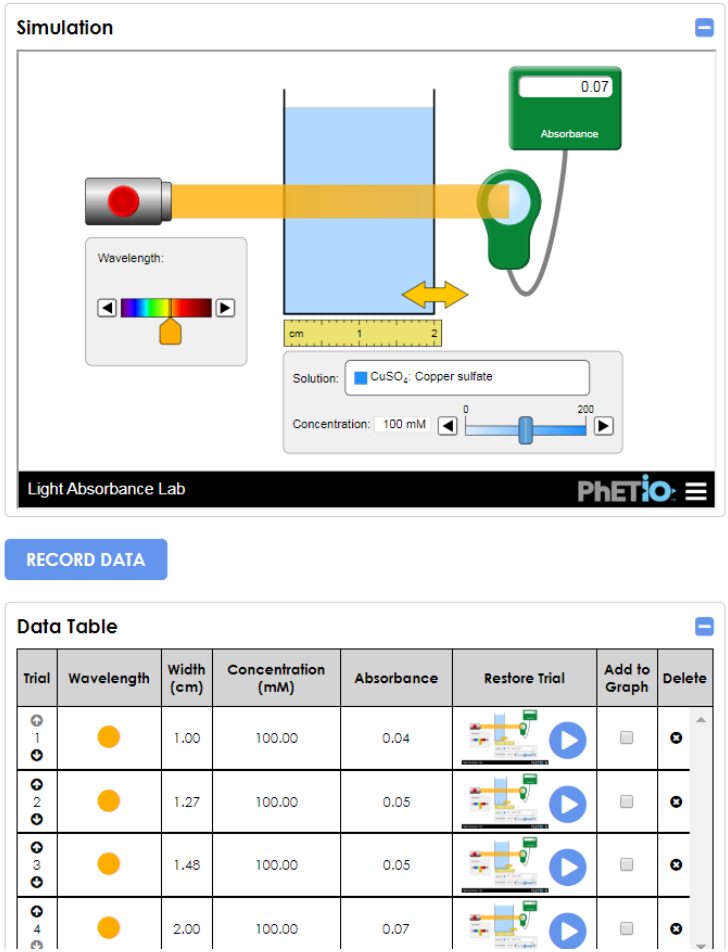
https://phet-io.colorado.edu

Frontiers: PhET-iO

PhET-iO Simulations

Customizable and Interoperable with Back-end data

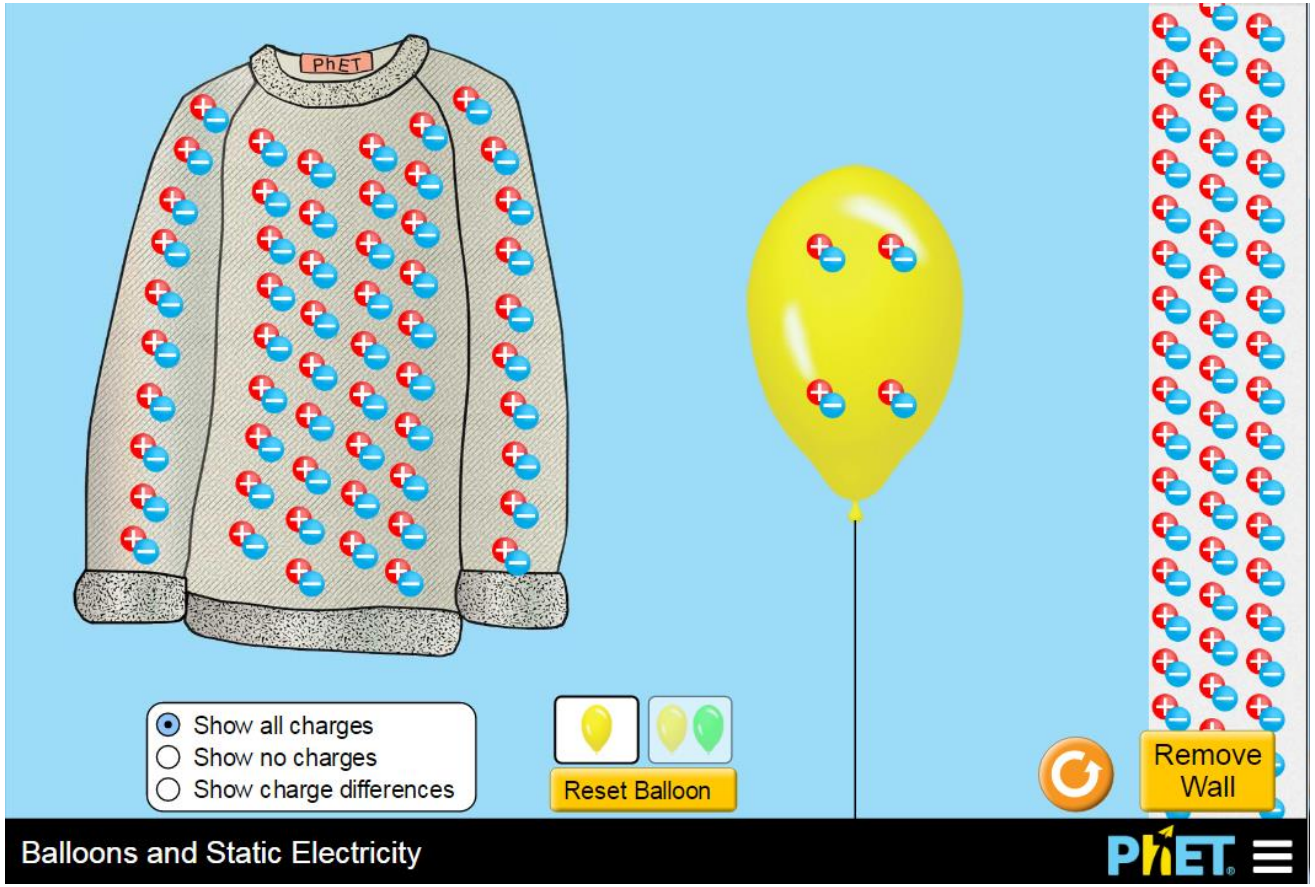




Frontiers: Accessibility

Emily Moore

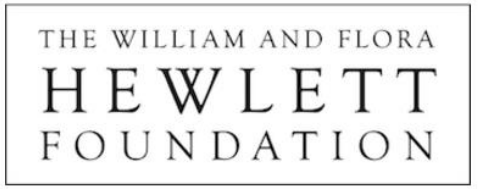
PhET Sims for Students with Disabilities



https://phet.colorado.edu/en/accessibility

Funders


NSF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FOUNDATION


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newschools
venture fund

Deep Dive

Planning use across course

Writing clicker questions and activities

Applying strategies

Invitation

FIND PHET	https://phet.colorado.edu
USE SIMS	In lecture, lab, homework
CONTRIBUTE	Lessons Register at https://phet.colorado.edu

PhET INTERACTIVE SIMULATIONS
University of Colorado Boulder

SEND IDEAS	**phethelp**@colorado.edu
CONNECT	@PhETsims /PhETsims

PhET Wordle

Teachers explain “how PhET impacts their students’ learning”