

# PhET Simulations

Cognitivism

Science

Constructivism

Math

Simulations

[PhET simulations](#) are interactive simulations of science and math concepts created by the University of Colorado Boulder. Students are able to run these simulations, manipulating different aspects of a construct to understand science and mathematics concepts. Depending on the simulation, students may also be able to collect, graph, and analyze data to draw conclusions of their own.



A brief introduction to PhET

[Watch on YouTube](#)

## Tool Snapshot

Price	Free
Learning	<a href="#">Constructivism</a> & <a href="#">Cognitivism</a>
Ease of Use	★★★★☆

<b>Privacy</b>	★★★★★
<a href="#">Accessibility</a>	★★★★☆
<b>Class Size</b>	Unlimited with individual devices, no more than 3 students per simulation
<a href="#">ISTE*S</a>	Knowledge Constructor & Computational Thinker

## PhET Simulations Overview

PhET simulations are especially useful for creating visual representations of hard to grasp concepts in science and math while making them engaging through student manipulation. PhET simulations are easy to access and free to use by anyone with a device and an Internet connection. There is no account or login required for use, but with a free account, teachers can also have access to teacher-submitted activities and primer videos. Overall, this is a great resource for making STEM concepts come alive!

## Usability

PhET simulations can be used on computers, tablets, and chromebooks but each has a slightly different set-up requirement. The simulations are free and do not require a license for educators and students but you do need an internet connection. If you wish to use the simulations offline, you can purchase them for \$0.99 for an iPad in the Apple store. Depending on your computer, there are specific software requirements:

Depending on the simulation you run, you may need to install Java. There is a lot of help specific to your device under the [Help Center](#) tab at the bottom of the page. It is strongly recommended that you either plan time into your lesson to allow for setup or have students do so the night before otherwise a lot of time will be lost to tech support rather than learning.

## Ease of Use

Teachers can browse for videos very easily, by selecting subject area, grade level, and or language. There is a tips section for teachers and the Help Center is incredibly useful. The simulations are very intuitive and require little to no explanation prior to letting students loose to explore concepts in science and mathematics. Because some of these PhET simulations are older, there might be some difficulty with the initial setup, which may involve installing Java and ensuring your students' devices are compatible with the particular simulation you have chosen.

## Accessibility & Equity

While they are working on adding accessibility features to all of their simulations, many of them have options for keyboard navigation, auditory descriptions and feedback, as well as sonification which is non-speech sound used to convey information like the strength of a magnet. Learn more at the [PhET accessibility page](#).

## Privacy

There is no login required, no account, it is just a program that students run on their device as a result their data is neither collected nor shared. A privacy policy could not be found on the main page, but here is the [privacy policy for the Android App](#).

## Power & Bias

While some of the simulations include animations of people of color and women, the simulations are produced by the University of Colorado and therefore are presented through a Western scientific point of view. One thing that is really

great is that many of their simulations have been translated into other languages - they have at least 1 simulation translated into 87 languages.

## PhET Overview Video



[Watch on YouTube](#)

\*\*\*[Video transcript](#)\*\*\*

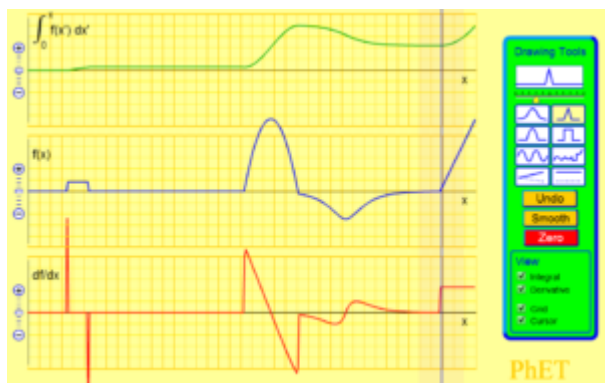
## PhET & the SAMR Model

- **Substitution:** Students use a simulation to watch a particular process take place rather than watching the process take place in person.
- **Augmentation:** Students engage with the simulation and are able to manipulate it, adding interest to the activity.
- **Modification:** Students use a simulation to observe, test, and gather data in order to develop an understanding of a particular concept that they then share with the class. This fuels inquiry based learning.
- **Redefinition:** Students are able to use simulations to observe, manipulate, and understand otherwise unobservable phenomena like molecular structures, membrane permeability, or the photoelectric effect.

## Learning Activities

### Math

Help students to better understand fractions and become more comfortable using them in mathematical operations by building, matching, and manipulating them. Have Calculus students determine the derivative or integral of certain graphic representations by manipulating graphs.



PhET Interactive Simulations" [screenshot] retrieved from <https://phet.colorado.edu/en/simulations/category/math>

## Science

Conduct a simulative field study on evolution and natural selection. Determine the properties of waves through investigation. Observe molecular movements across a membrane or in a neuron. Observe and interact with molecules and atoms up close to better understand the inner workings of matter. Or have students experiment with the photon absorption rates of different molecules and observe the greenhouse effect.



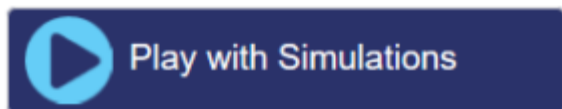
"PhET Interactive Simulations" [screenshot] retrieved from <https://phet.colorado.edu/en/simulations/category/math>

## Resources

- [Teaching Resources](#)
- [Resources for using PhET simulations in class – PhET Activities Database](#)

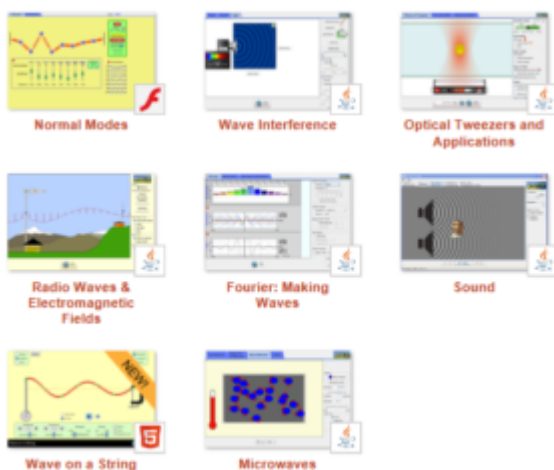
# How to Use PhET Simulations

1. Go to <https://phet.colorado.edu/>
2. Click "Play with Simulations."



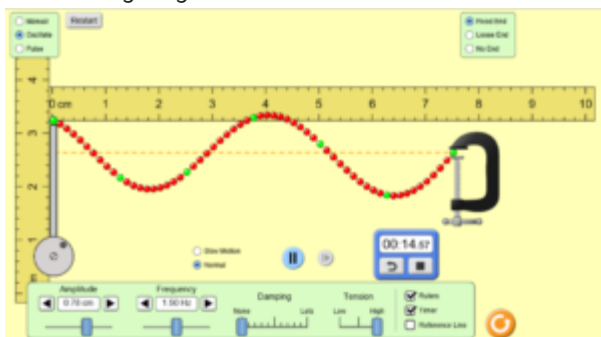
"PhET Interactive Simulations" [screenshot] retrieved from <https://phet.colorado.edu/>

3. Select your desired subject area from the menu on the left.
4. Click on the simulation you wish to run.



"PhET Interactive Simulations" [screenshot] retrieved from <https://phet.colorado.edu/>

5. Start investigating!



"PhET Interactive Simulations" [screenshot] retrieved from <https://phet.colorado.edu/>

6. If you have trouble getting the simulation to run, go to the [help center](#) where you will find answers to many of your questions, if not, contact the PhET.

## Research

Adams, W. K. (2010). [Student engagement and learning with PhET interactive simulations](#). *Il Nuovo Cimento C*, 33(3), 21-32.

Adams, W. K., Paulson, A., Wieman, C. E., Henderson, C., Sabella, M., & Hsu, L. (2008, October). [What levels of guidance promote engaged exploration with interactive simulations?](#). In *AIP Conference Proceedings* (Vol. 1064, No. 1, p. 59).

Ndihokubwayo, K., Uwamahoro, J., & Ndayambaje, I. (2020). [Effectiveness of PhET simulations and YouTube videos to improve the learning of optics in Rwandan secondary schools](#). *African Journal of Research in Mathematics, Science and Technology Education*, 24(2), 253-265.

Wieman, C. E., Adams, W. K., Loeblein, P., & Perkins, K. K. (2010). [Teaching physics using PhET simulations](#). *The Physics Teacher*, 48(4), 225-227.



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