

BEST HIGH SCHOOL PHYSICS STUDENT RESOURCES

For best high school physics student resources to reinforce and supplement instruction (especially Modeling Instruction), below is a list of websites recommended by teachers of first-year physics students, including AP and Dual Enrollment. (Updated in October 2018; compiled by Jane Jackson)

Use them to REINFORCE learning in the classroom, not before classroom instruction. Otherwise, students are tempted to memorize, rather than think and reason.

Note: we do NOT recommend the KhanAcademy, because high school physics teachers and college physics faculty report 1) major errors in physics content, 2) ineffective pedagogy. See Frank Noschese's blog for evidence: <http://fnoschese.wordpress.com/tag/khan-academy/>

PHYSICS INSTRUCTION:

1) **THE PHYSICS CLASSROOM** <http://www.physicsclassroom.com>

Tutorials by Tom Henderson, a high school physics teacher at Glenbrook South High School in Glenview, Illinois. Also interactive question/answer sets, Shockwave simulations, tips for teachers, narrated demonstrations, lab manuals. A **Physics Front** "Elite Choice". [Modeler Marc Reif wrote in 2014, "The website is, I think, a useful resource for students, even though it does not follow the modeling units or consistently use the same notations and structure as modeling."]

2) **SPIRAL PHYSICS**, by Paul D'Alessandris, Monroe Community College, is a wealth of research-based conceptual/quantitative activities for calculus-based physics and algebra-based physics (grades 11-12 and college). Free downloadable modules for students. Dwain Desbien, an expert modeler at Estrella Mountain Community College, uses Spiral Physics extensively. He wrote in May 2015: "I use parts of it in all my classes. I particularly use it in University Physics 2 and 3. It is a great resource for activities."

<http://www.dropbox.com/sh/oulpsaytsjxvhzh/AADt7uvQWqNgOXOz5B-YrQXba?dl=0>

3) **LEARN AP PHYSICS**. <http://www.learnapphysics.com> Lessons developed for AP physics students; site is maintained by Richard White, an AP physics teacher in southern California. Lessons are from three sources: the Monterrey Institute (open source: California Board of Regents), M.I.T. (OpenCourseWare) and the Mechanical Universe & Beyond.

HOMEWORK:

<http://per.physics.illinois.edu/resources/interactive-examples/>

Illinois PER: Interactive Examples

Unique collection of interactive homework problems for algebra-based and calculus-based introductory physics. All problems are designed in a Socratic-dialog format with immediate feedback provided at each step. Developed by Gary Gladding. A **Physics Front** "Elite Choice."

SIMULATIONS:

<http://phet.colorado.edu/>

PhET: Physics Education Technology

Award-winning set of 100+ interactive simulations for physics, chemistry, and biology.... Many have been classroom-tested in grades 6-12. A **Physics Front** "Elite Choice".

Frank Noschese's list of Physics Applets & Animations, organized by concept, at

<http://fnoschese.wordpress.com/physics-applets-animations/>

LABORATORY INVESTIGATIONS (virtual experiments):

<http://paer.rutgers.edu/pt3> The Rutgers Physics Teaching Technology Resource (PT3) won the AAAS Science Prize for **Online Resources** in Education (SPORE) in 2010. It is popular all over the world in schools ranging from middle schools to universities. Some institutions rely on it for all of their physics labs. In some cases, students say the web site's videos illustrate concepts in ways that hit home like no other explanation. The web site explains how to use the videos, describes the underlying teaching philosophy, and provides examples of how students can work with the videos. The ~200 downloadable videos work with any curriculum and with any textbook and are supported by questions, all of which allow students to work independently at their own pace. Authors are Drs. Eugenia Etkina and David Brookes.

<http://www.pivotinteractives.com/direct-measurement-video> **Pivot Interactives** (formerly Direct Measurement Videos). For a small fee, you can do hundreds of virtual experiments in high school or college physics, supported by questions. 150 activities. Integrated components: videos and tools, instructions, graphing.

REAL-WORLD CONNECTIONS (videos for AP physics & chemistry, calculus, engineering):

<http://tll.mit.edu/help/stem-concept-videos> MIT's Teaching and Learning Laboratory (TLL) has created 47 STEM Concept Videos to help students connect the concepts they learn in introductory STEM courses to concrete, real-world problems. Students can watch the videos to prepare for class or review a concept for an exam. Instructors can use them to supplement classroom instruction, using snippets or the entire video, most of which are under 15 minutes. Throughout the videos, viewers are prompted to pause to actively engage with the material — to predict the result of demonstrations, engage in a discussion of concepts, or perform activities tied to the video's intended learning outcomes.

Some examples of questions that the videos pose include:

What is the connection between martial arts and torque?

How can the concept of latent heat be used to design more energy-efficient buildings?

The videos utilize animations, visualizations, demonstrations, and examples from engineering and science disciplines. They grab the viewer's attention by asking a provoking question or describing a real-world phenomenon. They tell viewers what prerequisite knowledge they will need to understand the topic and what they will learn by watching the video.

NAÏVE CONCEPTIONS:

<http://www.compadre.org/IVV/> Interactive Video Vignettes (IVVs) are available for free. Each online vignette addresses a learning difficulty identified by PER. They take about 10 minutes to complete.

IVVs are designed for use as online assignments such as homework, pre-class tutorials, flipped-classroom lecture segments, or Interactive Web Lectures. The interactivity helps engage students and keep them focused.

Derek Muller, the creator of the popular science-video website Veritasium.com, found in his dissertation research that "explicit discussions of alternative conceptions are more effective for learning than expository summaries." Consequently, many vignettes show the instructor, students, or other participants discussing all possible answers to multiple-choice questions. The vignettes developed so far include instructor-led presentations, "person-on-the-street" interviews, discussions between students and instructors, and stories played out by student actors.

NINE vignettes are available in fall 2018.

- * Projectile Motion: Independence of vertical and horizontal motion.
 - * Newton's First, Second, and Third Laws (3 vignettes).
 - * Bullet-Block (with Derek Muller): Conservation of momentum in an inelastic collision.
 - * Circular motion
 - * Electrostatics (3 vignettes)
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OTHER RESOURCES:

Many resources are at The **Physics Front**, a free service of the American Assn of Physics Teachers (AAPT) for pre-college teachers. Resources are reviewed; priority is given to materials that promote engaged learning, visualization, student interactivity, and multimedia experiences.

<http://www.compadre.org/precollege/>

Some modeling-friendly resources are at <http://modeling.asu.edu/modeling/weblinks.html> in the section called "flipped classroom".

If you have favorite suggestions, please email jane.jackson@asu.edu so that she can add them.