Teaching AP Physics 1 to the World

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APS New England Meeting
Boston University
AP Physics What?

- AP = Advanced Placement, exams run by College Board in May for high school students
- AP Physics B (algebra-based) has been replaced by AP Physics 1 + AP Physics 2
- AP Physics C (calculus-based) Mechanics + E&M courses still exist
AP Physics 1 Topics

- Basic mechanics (kinematics and Newton’s laws)
- Circular motion and gravitation
- Conservation laws - momentum and energy
- Rotation (kinematics, torque, static equilibrium, dynamics, angular momentum)
- Simple harmonic motion + waves
- Electric charge
- Basic DC circuits
The course

- Preparing for the AP* Physics 1 Exam
- 14 modules, 16 weeks
- 10K+ students from 148 countries
edX High School Initiative

RiceX
AdvPHY2.4x
Preparation for the AP* Physics 2 Exam – Part 4: Exam Review

Weston High School
MechC101x
On-Ramp to AP* Physics C: Mechanics
edX High School Initiative

MITx
8. MechCx
Advanced Introductory Classical Mechanics

GeorgetownX
PHYX152x
Preparing for the AP* Physics C: Electricity and Magnetism Exam
Enrollment - 10,000 students

Sept. 2014, opens for enrollment
Jan. 5, 2015, course begins
May 4, 2015, course ends
Age of students - from 0 to 100+

35% female, 64% male
Educational background

Education Metrics

- 63.0% High School Diploma or Less
- 18.6% College Degree
- 15.2% Advanced Degree
148 countries represented
Student Engagement (number of students)

- any
- attempted_problem
- played_video

Mar. 2-8 | Mar. 16-22 | Mar. 30-Apr.5 | Apr. 13-19
0 | 500 | 1000 | 1500
500 | 1000 | 1500 | 2000
1000 | 1500 | 2000 |
The content team

Mark D. Greenman
BU Teacher-in-Residence

Aaron Osowiecki
Boston Latin School

Brandon Schmidt
Newton South HS

Adam Wolf + Tyler Wooley-Brown
Brookline High School
Other key players

Digital Learning Initiative

Chris Dellarocas

Tim Brenner

Romy Ruukel

Vanessa Ruano
Other key players

- David Pritchard’s group at MIT
- Zhongzhou Chen
- Chris Chudzicki
- Saif Rayyan
- Mark Rudnick
- Elina Hu
Module overview. Each module has ...

- Essentially, an online textbook, but interactive
- Exploratory activities - learn by doing
- Simulations
- Quizzes
- Labs
- End-of-module assessment modeled on the AP Physics 1 exam
- Screen-cast videos (in a supporting role)

Philosophy: make the experience as interactive and minds-on as possible for the student.
Types of questions we use

**QUESTION 7**  (1 point possible)  multiple choice

Two balls are launched from ground level with the same launch angle, but ball B's initial speed is twice as big as ball A's initial speed.

Compared to ball A, ball B goes...

- twice as high, has twice the range, and spends twice as long in the air
- four times as high, has four times the range, and spends twice as long in the air
- twice as high, has twice the range, and spends four times as long in the air
- four times as high, has four times the range, and spends four times as long in the air

[Check] [Save]  You have used 0 of 2 submissions
Types of questions we use

QUESTION 9  (1/1 point)  multiple select

Let's say that the resistance of the 6 Ω resistor is increased somewhat. What effect will this have on the current through the various circuit components? Choose the two correct answers.

- ✔ The current through the now-larger-than-6 Ω resistor will decrease
- ❑ The current through the 3 Ω resistor will stay the same
- ✔ The current through the 4 Ω resistor will decrease
- ❑ The current through the battery will stay the same
Types of questions we use

QUESTION 12  (3/3 points) numerical

The mobile shown above is in static equilibrium. The mass of the triangle is 480 g.

What is the mass of the oval, in grams?

120
Types of questions we use

QUESTION 8 (4 points possible) symbolic

Determine expressions for the following quantities in terms of M, X, D, h, or g. Note that these symbols do not include the spring constant. Examples: the square root of M can be written as sqrt(M). M squared can be written as M^2. A quantity such as g multiplied by h can be written as g*h, so you need to explicitly include a multiplication sign.

Write an expression for the time elapsed from the instant the block leaves the table to the instant it strikes the floor. Explicitly indicate multiplication with a * symbol.
Types of questions we use

drag and drop
The challenge of doing labs online

- Peer-graded activities, in which students submit a report and then grade their peers.
- Peter Bohacek’s Direct-Measurement Videos
- PhET simulations (University of Colorado)
- HTML5 simulations, mostly written by Aaron Osowiecki and me, but also some from Frank McCulley
Peer-graded activities

- Five within the course
- Example: carry out measurements on a simulated series circuit and a simulated parallel circuit, and then write up a lab report, responding to particular questions
- Grade four other reports, following a grading rubric
- Each report graded by at least three other students
- The point - to prepare students for the open-ended questions that make up 50% of the AP Physics 1 exam
Direct-measurement videos

- High-speed videos with measurement tools overlaid, created by Peter Bohacek, a high school physics teacher at Henry Sibley High School in Minnesota
- Search for “direct measurement videos” - connect to a fantastic resource for teaching physics
- 91 videos available at the Carleton College Science Education Resource Center (SERC)
Direct-measurement videos
Direct-measurement videos

Airplane on a string

© Peter Bchacek ISD 197

© Boston University
Direct-measurement videos

Airplane on a string

length

mass

speed

period

String tension (N)

frames+0

120 frames per second

© Peter Bohacek ISD 197

© Peter Bohacek ISD 197
Direct-measurement videos

Fan Cart Accelerates
8x Slow-Motion  Force #3

Frames: 690
240 frames per second
8x slow motion
Interactions with students

- All asynchronous, on the discussion forum
- (Tried online office hours - nobody came)
- Only a small number of students on the forum
- Some of the students are amazing, and act as teaching assistants
- Almost every response to a student’s post is positive and helpful
- One thread had 29 different posts, with a discussion lasting a few weeks
Future plans

- The course is available in archived form on edX after the course closes, but ...
- ... after all this work, we plan to run it again next year.
- With improvements.
- Re-mix the content for our first-semester algebra-based intro. physics class on campus (about 380 students).
- With Peter Garik of the School of Education, re-mix for a Force and Motion course for physics teachers in Fall 2015, building on our Improving the Teaching of Physics (ITOP) program (running since 2004).
- Do some research with all the data we have.
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