

Breaking Barriers in Home Study Science Home Labs and Science Distance Education

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CIDER Sessions Season 2017-18

March 21, 2018

Opening the Doors of the Laboratory: Distance Education Science

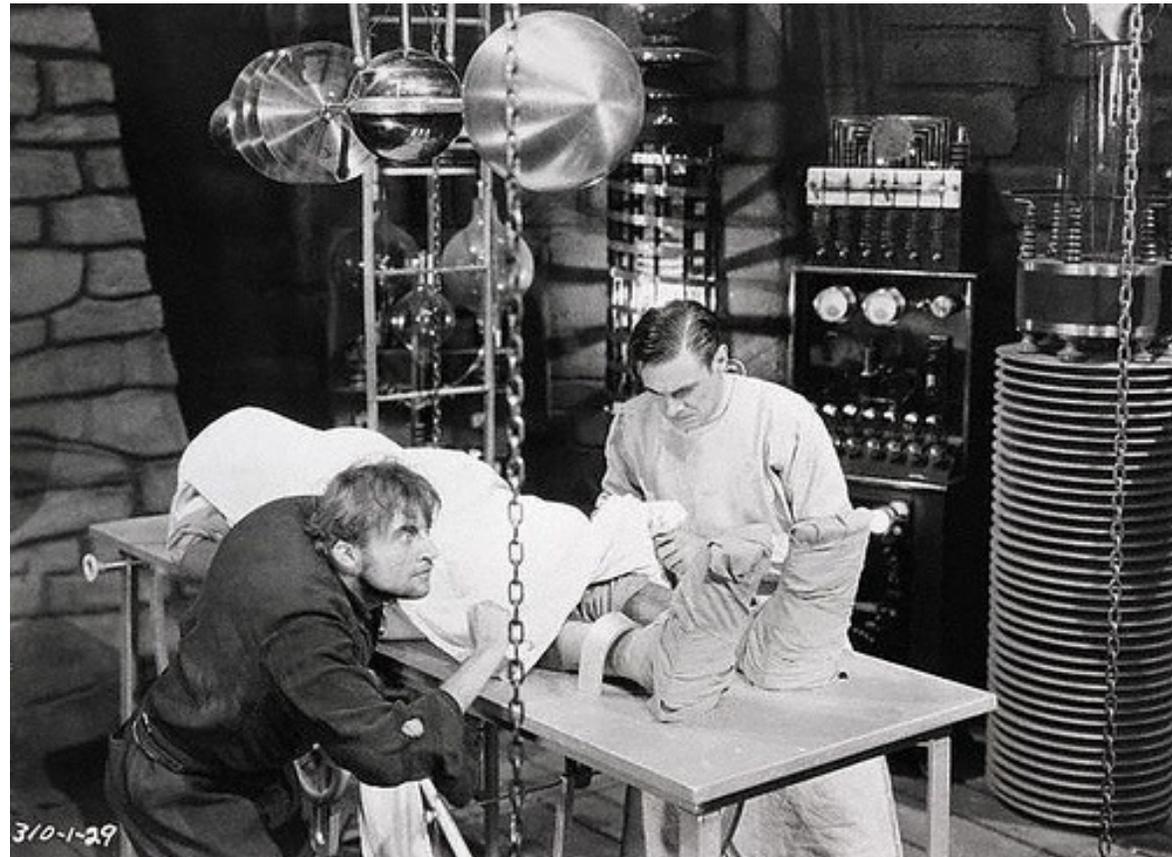
Martin Connors

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Thanks to ..

Rafael Hakobyan

Elaine Goth-Birkigt



The monster in the room: How can an online course have labs?

How about virtual reality?

No, Science is *real* reality!

Less “tongue in cheek”, accepting institutions do not want something so different.

A real experiment has to happen with modern technology this can be:

At home

online



Frankenstein (1931) copyright expired

What is an Experiment?

Tests a hypothesis

Gets data

I can ace the labs and get into med school

boring

Cool, rats are so smart!

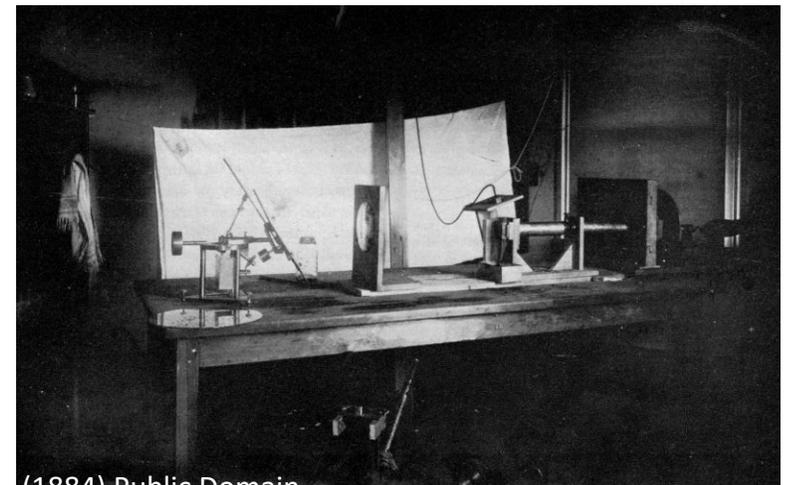


Artist: Stuart McMillen, <http://www.stuartmcmillen.com/blog/cartoon-blog/bustle-cagerow-making-rat-park/>

Why make students do experiments?

- ❑ Connect the curriculum to the real world
- ❑ Learn about uncertainty and how to test
- ❑ Practical experience with equipment
- ❑ Testing (weed out klutzes from surgery)
- ❑ Everybody else does it

In many cases, freshman labs are straight out of the 17th, 18th, or 19th century!



(1884) Public Domain

The Solution



"Lab glassware" by Tweenk - Own work. Licensed under CC BY 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Lab_glassware.jpg#/media/File:Lab_glassware.jpg

Distance Education Motivation

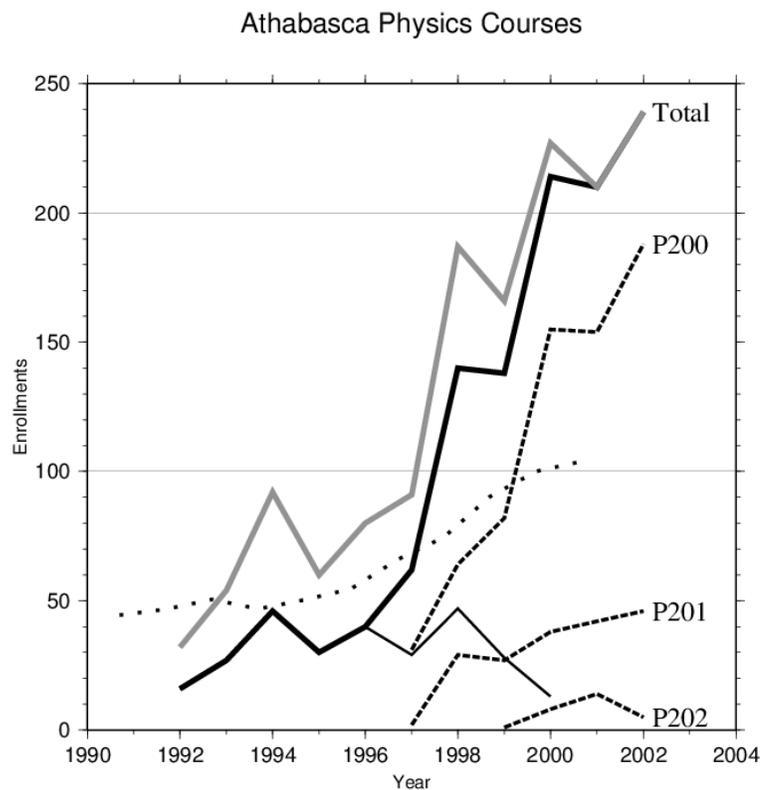
Students enroll in distance education because they do not want to come to campus!

So why bring them to the lab when you can bring the lab to them? “Home lab”



Canada Post – unaltered in accordance with usage rules

If you build it they won't come...



Now about 500 physics students per year



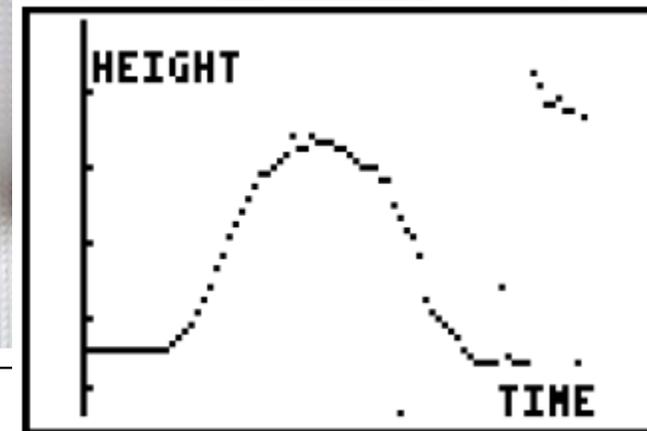
First Physics Home Lab Kit (1997) brought about a large enrollment increase!

Blast from the Past

We could send Calculator-Based Labs from Texas Instruments in a small package.

The calculator could make data graphs on its screen.

This was 1997!



When PCs became universal, could transfer over data.

Modern Lab Kits

Calculators are now a thing of the past (for labs at least).

Modern sensors plug into the computer with USB link.

“Graphical Analysis” software shows data as it is collected and allows fits to data.

(Electricity and Magnetism Lab kit shown)



Link

Electric Current Sensor

Business end of success

Lab kits are refurbished in our lab,
loaned by library or us directly, sent out
by post or courier

These are CHEM kits: now used in PHYS,
BIOL, GEOL, CHEM

Photo: 2015 Sue and Derrick
Rowlandson Memorial Award for Service
Excellence winner Rafael Hakobyan



**Over 1000 kits per year
loaned to students**

Biology kit



Old style physics kits



New style physics kit with packing list



Now for something completely different: **Remote Labs**

Philosophy: a lab should still take place, but remotely controlled online by the student

In a real lab, errors take place, and the student must use judgement in taking data and analyzing it

Visual feedback is also essential for a real experience

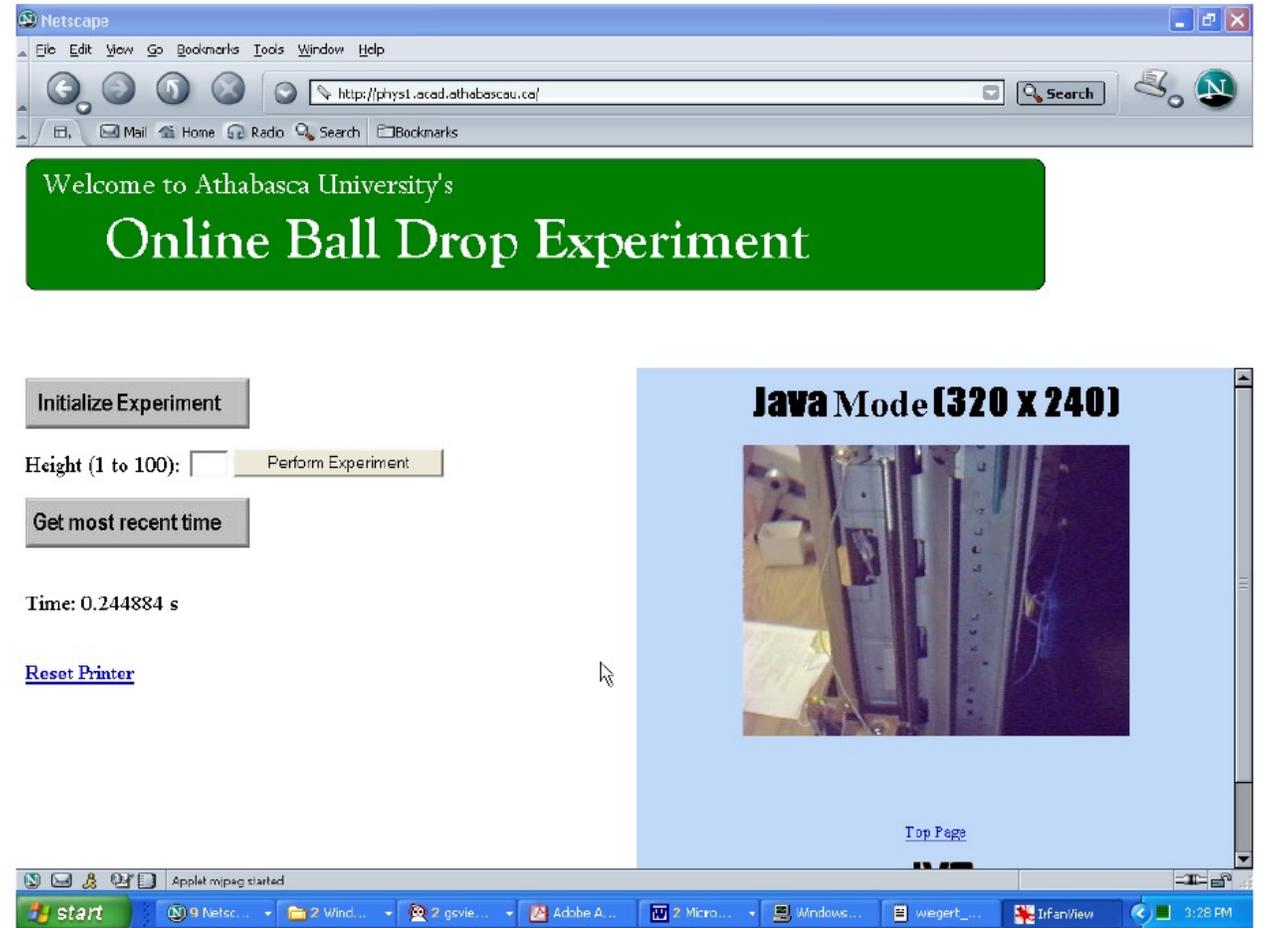
Further, by doing the lab, the student gets a feeling of *ownership* of the data

Historic Rube Goldberg Attempt at Online Labs (2002)

What students saw:

web page with one variable (height) and one output (time to drop)

Also a webcam picture to show that they were doing a real experiment



Anybody been to the Computer Museum?



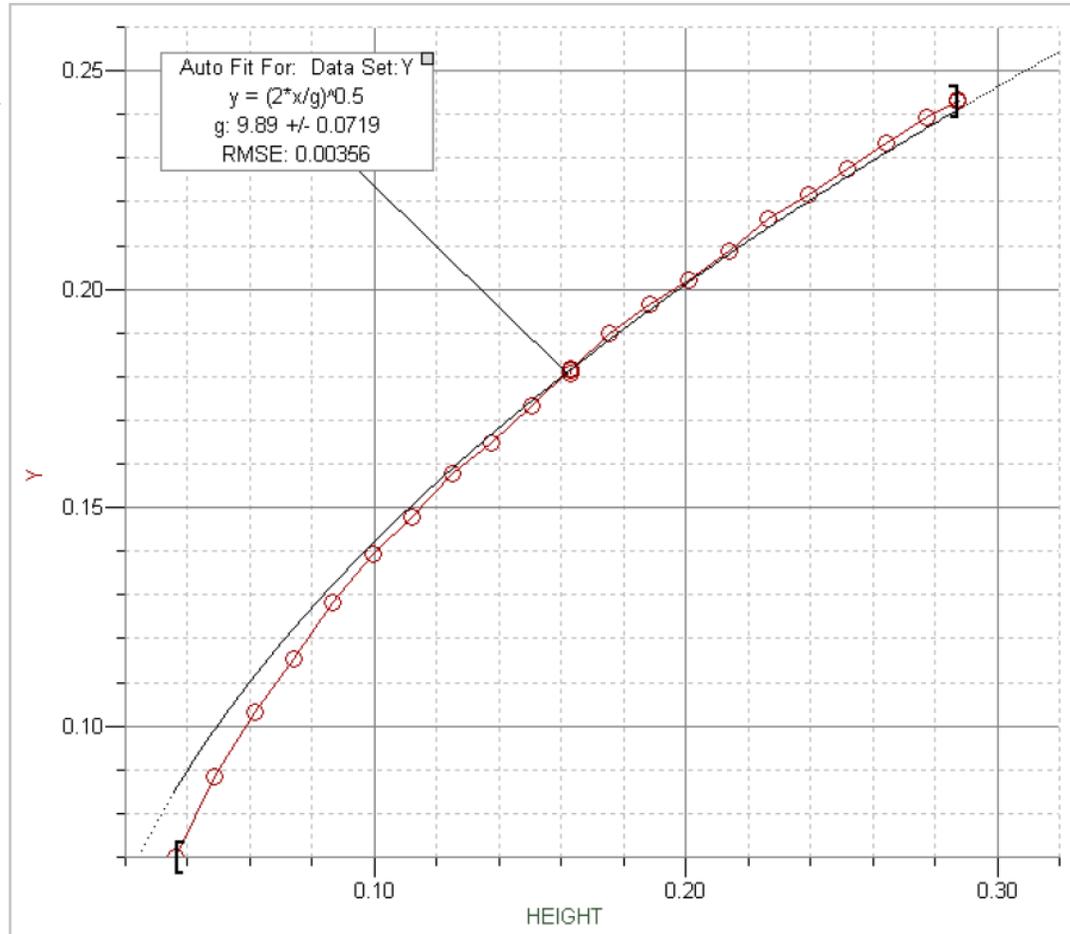
There used to be a thing called a dot matrix printer! If you tip one on its side and tell it to print, it can pick up a metal ball with a solenoid, then time the fall, all under control of a Microchip PIC, hooked to the Internet with a "SitePlayer". (Webcam not shown).

But, pretty good results!

If you drop something from higher up, how long it takes to fall is longer.

This device could measure that with microsecond precision.

A classic Physics undergraduate lab, done online!

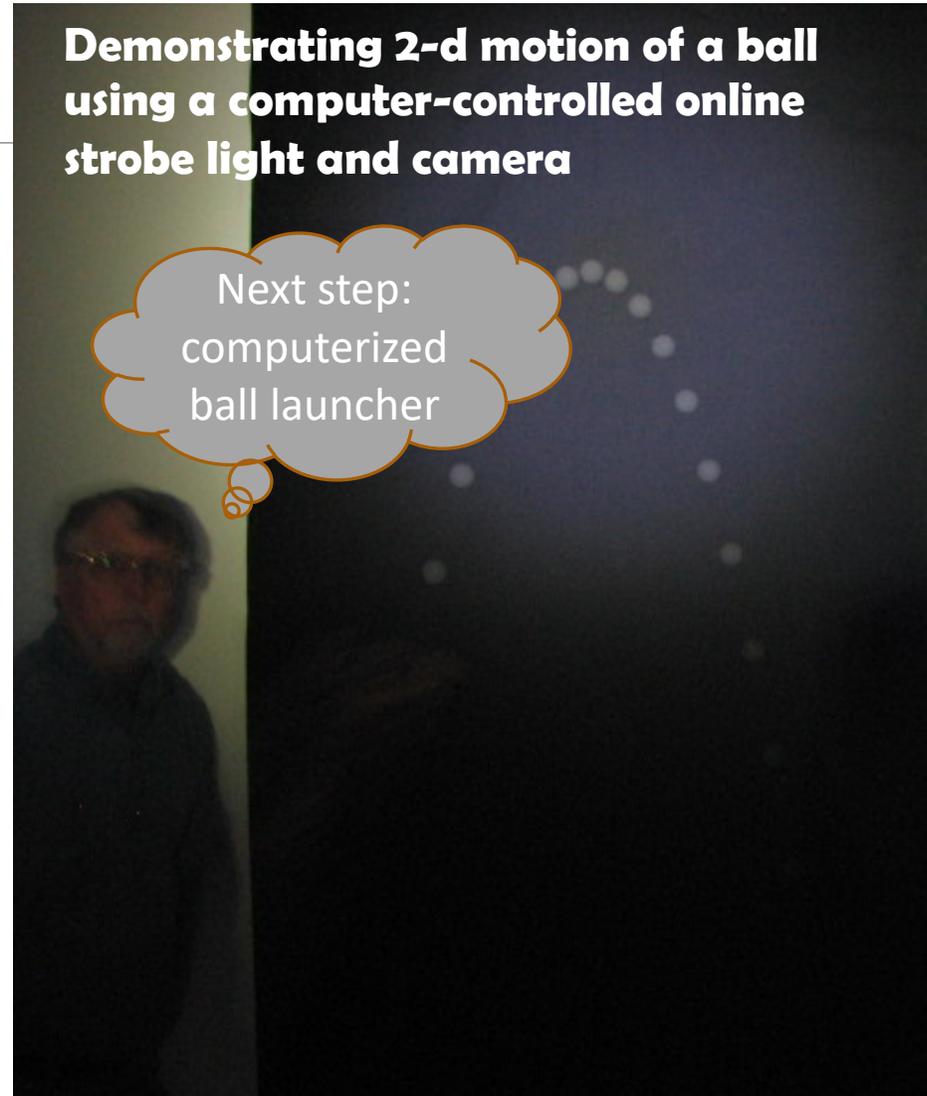


Return of telepresence with modern technology



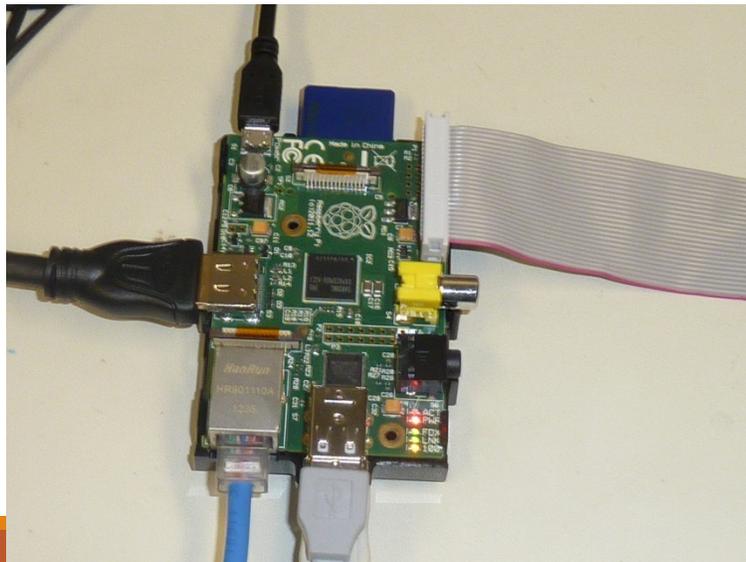
Demonstrating 2-d motion of a ball using a computer-controlled online strobe light and camera

Next step:
computerized
ball launcher



Science experiments in the World of Things

\$35 now gets you a linux system (Raspberry Pi) to go online, develop code, run headless to run the experiment



An inexpensive camera is controlled by “gphoto2”. The expensive part is the \$1000 programmable flash generator

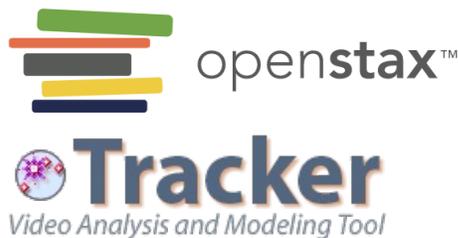


Instruction in Transition

- ❑ Conventional practices being challenged
- ❑ Open Educational Resources growing
- ❑ Multimedia production getting easier
- ❑ Interactivity & mobility now expected
- ❑ Research-based instructional methods/design
- ❑ Goal: Increased learning efficiency
- ❑ Goal: Reduced cost to University and student

Teaching Online - PHYS 200

- Introductory Physics I (classical mechanics)
- Algebra-based
- Locally developed study guide
- Mandatory lab component
- Mobile friendly
- OER textbook
- OER software



Mail - farooka@athabasca... Physics 200: Introductory

phys200r7.athabasca.ca/study-guide/unit10/index10.html#

Apps Settings Office 365 AU Moodle Newton Alfresco

Lab 1 Lab 2 Unit 3 Lab 3 Unit 4 Unit 5 Lab 4 Assignment 1 Midterm Exam Unit 6 Unit 7 Unit 8 Lab 5 Unit 9 Unit 10

Moment of Inertia of a Rigid Body

To see how the moment of inertia of a rigid body is computed, we consider a simple example—a thin hoop, of radius R and mass M , which can rotate about its cylinder axis, as shown in **Figure 10.4**. If we imagine the hoop as a composition of very small sections, of masses m_1, m_2 , etc., then each section can be treated as a particle allowed to rotate along a circular path of radius R . In addition, each section of the rigid hoop experiences the same angular acceleration α .

Figure 10.4: A thin hoop, of radius R and mass M , rotates about its cylinder axis.

The total torque on the rotating hoop of **Figure 10.4**, can be calculated by adding the individual torques on the imaginary

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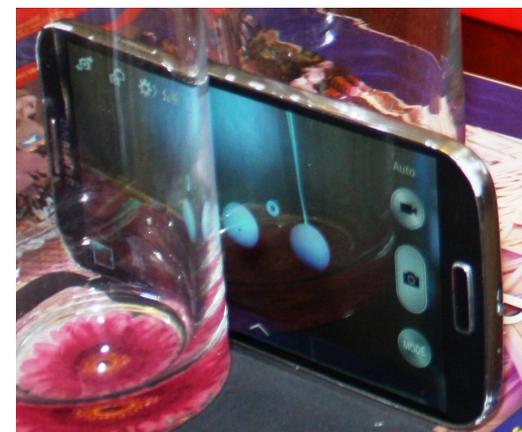
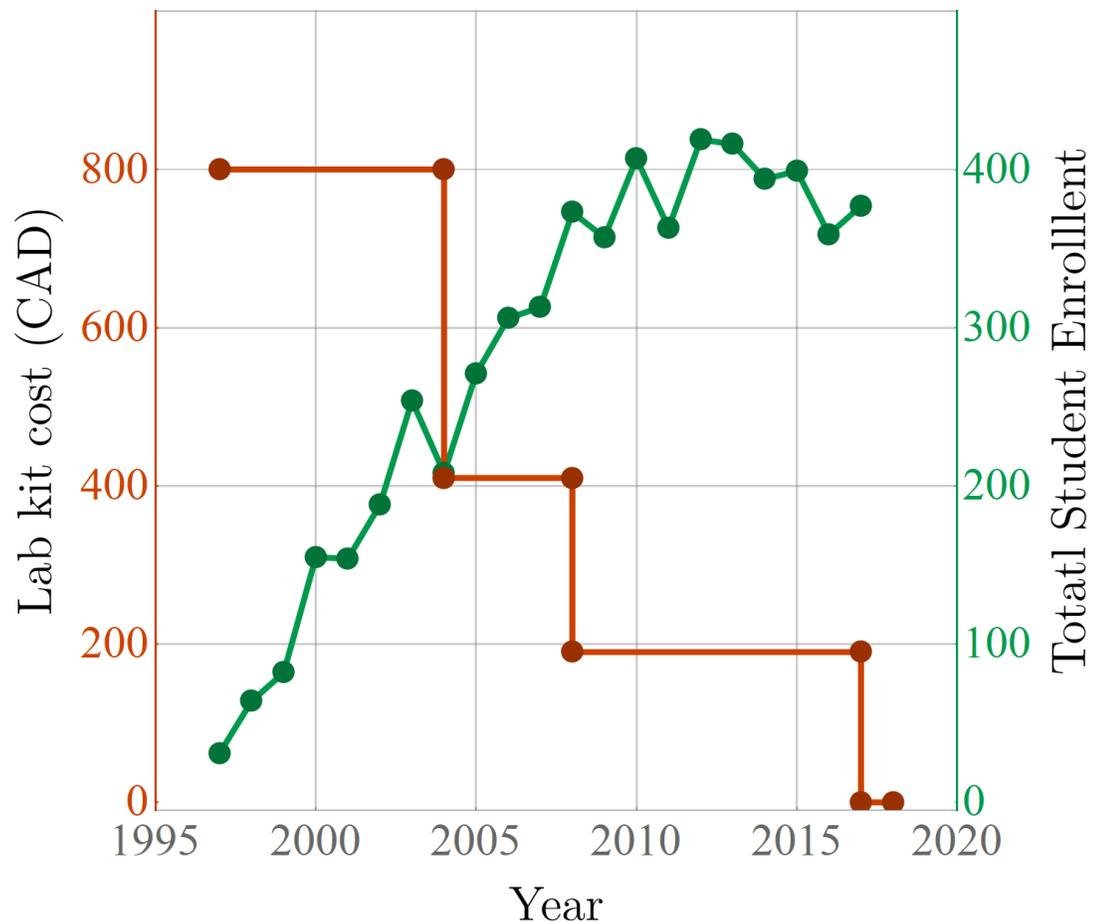
Figure 10.4: A thin hoop, of radius R and mass M , rotates about its cylinder axis.

Physics Home Lab

- ❑ Done anywhere
- ❑ Quality hands-on experiments
- ❑ Independent preparation of setup
- ❑ Full data analysis
- ❑ Detailed lab reports submitted

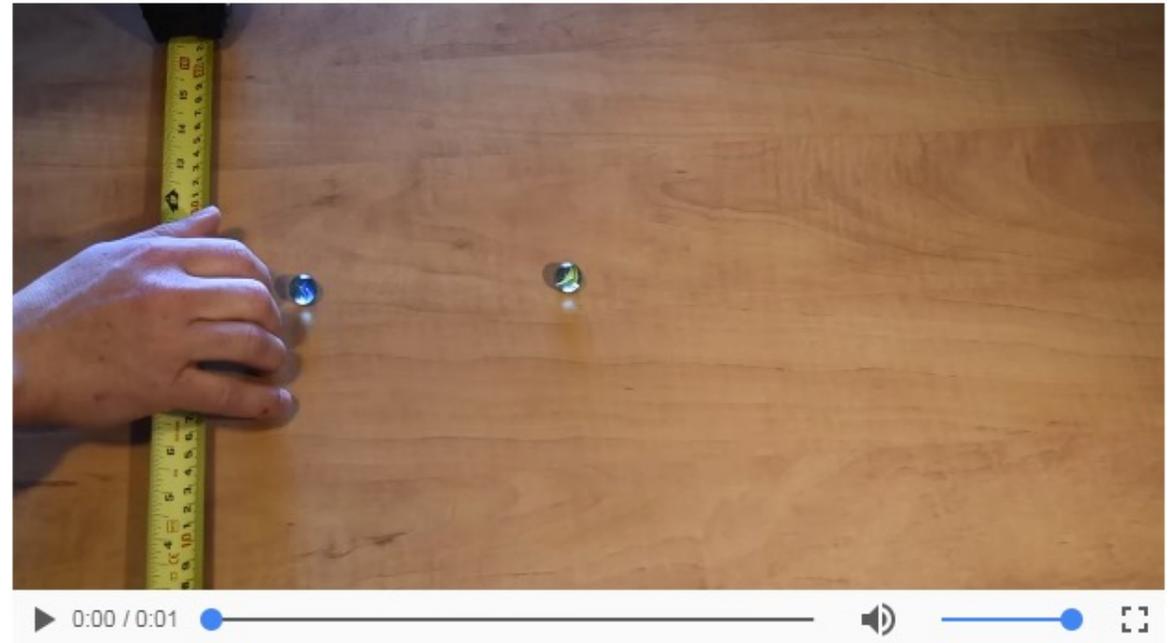


The Lab Kit Evolution - PHYS 200



Kit-Free Advantage - PHYS 200

- ❑ Financial savings (equipment, shipping, infrastructure)
- ❑ No kit shipment issues (especially out of country)
- ❑ No waiting list
- ❑ No borrowing limitations
- ❑ Enhanced lab quality



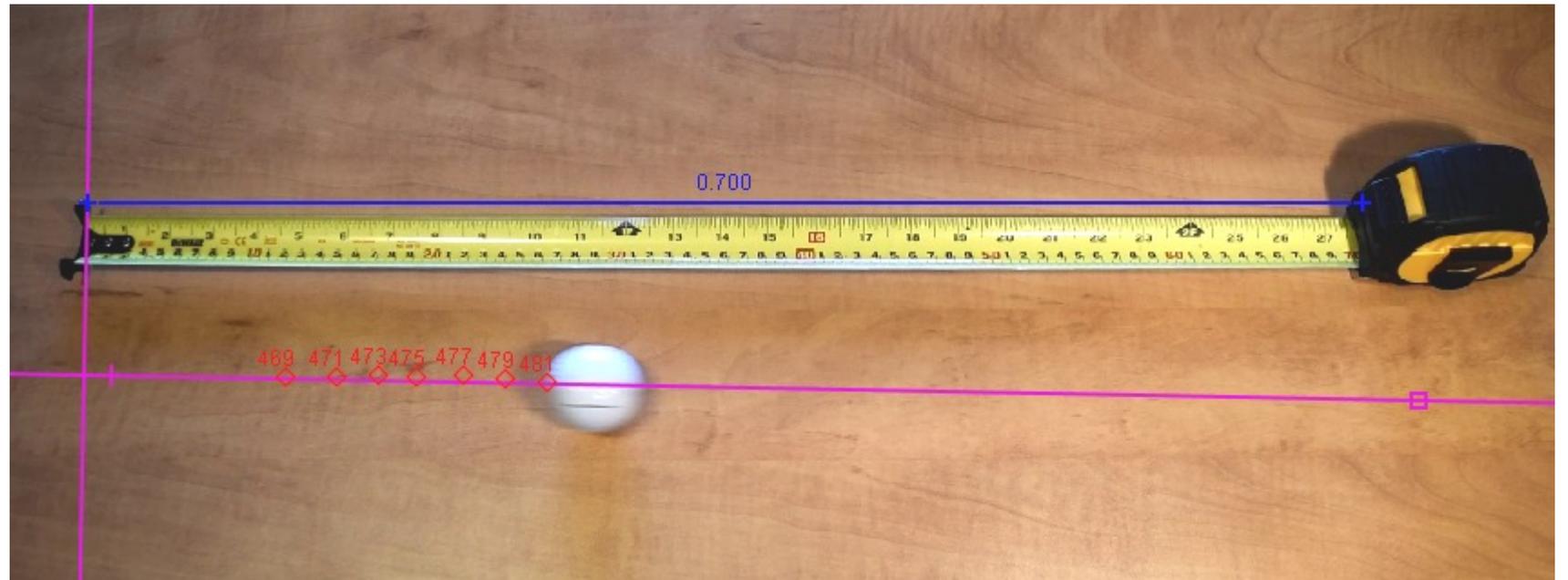
Smartphone Advantage

- ❑ Each student has one
- ❑ High-tech Device
- ❑ More apps are developed
- ❑ HD camera



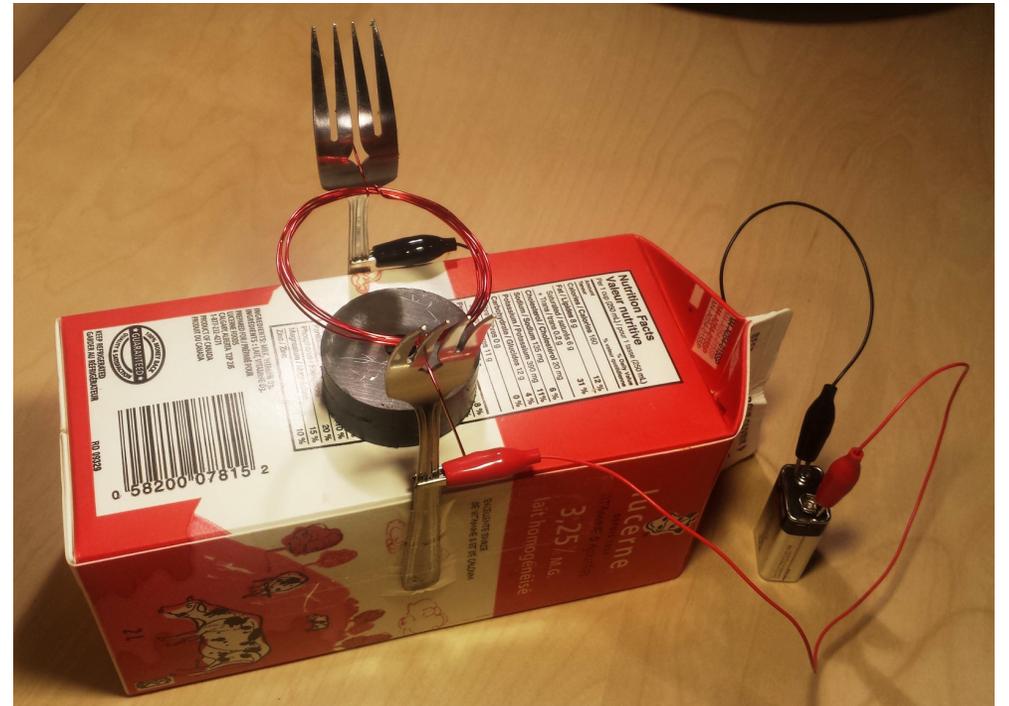
Video Analysis

- ❑ Straightforward with OER software
- ❑ Allows motion analysis in 2D
- ❑ Accurate



Lab Flexibility - PHYS 205

- ❑ Investigative approach (less strict procedure)
- ❑ Lab project (e.g. the electric motor)
- ❑ Open lab project (new ideas)
- ❑ The video report option



What we have learned?

- ❑ Home labs can be incredibly cost effective (compared to the capital cost of on-campus laboratory buildings)
- ❑ Sending stuff out in the “mail” is a viable part of online business models (like Amazon/Fedex)
- ❑ Learning outcomes are accepted for transfer credit
- ❑ High tech is a real part of the sensors in the kits but not all labs need high tech
- ❑ Telepresence can make “real” labs available online

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- ❑ Mobile devices are currently common house items
 - ❑ Devices are increasingly sophisticated and more user friendly
 - ❑ Students are getting more tech savvy
 - ❑ Should adapt to the YouTube generation
 - ❑ The video report is a viable option



Thank You

Athabasca
University
Science:
pioneering
instruction
since the
1980s.
A leader for AU
2.0!