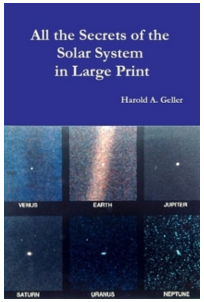
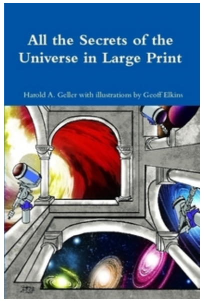
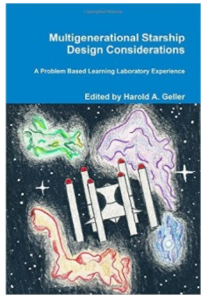
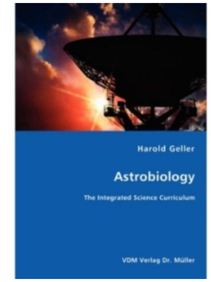
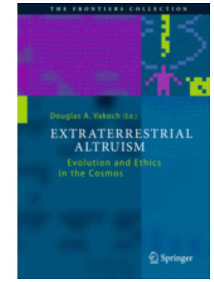




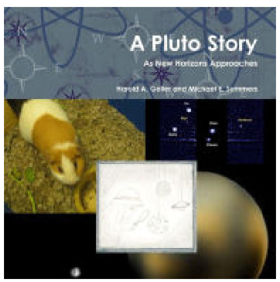


Chesapeake Section





Hands On/Hands Off: Two Approaches for Physics Fundamentals in Physics and Astronomy Classes



By
Dr. Harold Geller, Associate Professor
George Mason University
NASA/JPL Solar System Ambassador
at Randplph Macon College
23 April 2016

SOLAR SYSTEM AMBASSADORS PROGRAM

GEORGE MASON UNIVERSITY

ABSTRACT

Attendees will be exposed to a number of fundamental demonstrations and laboratory activities as utilized in physics and astronomy lecture and laboratory sections. The concepts covered include topics from mechanics to electromagnetism. We will also discuss the pros and cons of computer simulations versus hands-on activities.

Computer Simulations

- Different forms
  - "Local" software
    - Computer simulations done in a physics class in lieu of standard physics experiments
      - Examine mechanics and electricity and magnetism
  - Online simulations
    - PhET
      - Examine mechanics and electricity and magnetism

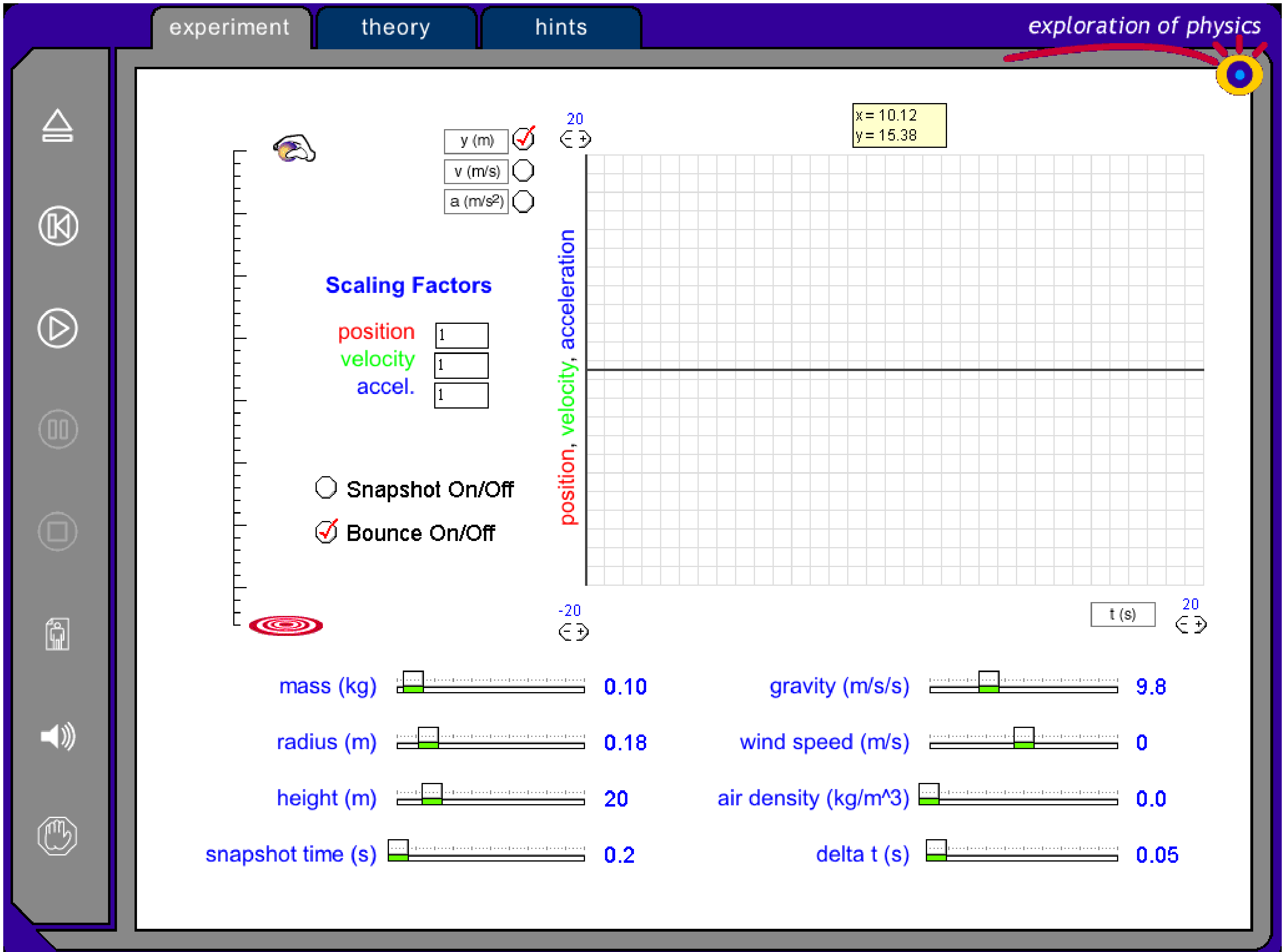
Description of “Local” Software

- Exploration of Physics Volume I
  - Written by Raman Pfaff, University of New Haven and John Di Bartolo, Polytechnic Institute of NYU
  - Published by *Physics Curriculum & Instruction*
    - Publisher is organized to act as both a developer and publisher of physical science educational materials
- Comprehensive software library of physics simulations and labs
  - covers a full year of introductory physics
    - Mechanics, Waves, Heat, Fluids, Optics, and Electricity & Magnetism

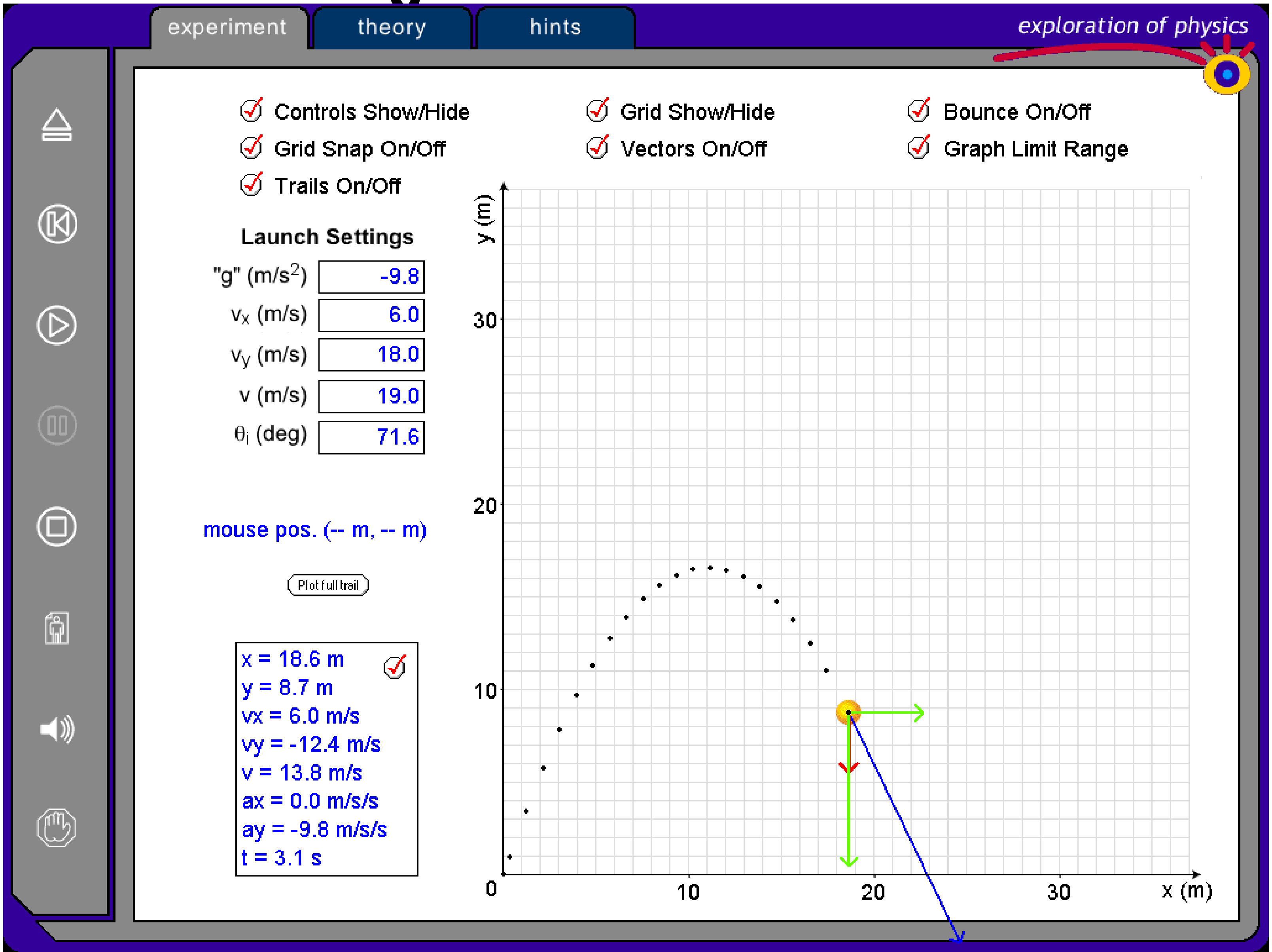
Virtual Labs Utilized

- Free fall laboratory
  - In vacuum and with air resistance
- Projectile Motion
- Inclined plane
  - With no friction and with friction
- 1^{st} Law of Thermodynamics
  - Energy conversion
- Electricity and Magnetism
  - Resistive circuits
    - Resistors in series
    - Resistors in parallel
  - Lenz's Law
    - Producing magnetism from electricity
      - Varying number of loops
      - Varying area

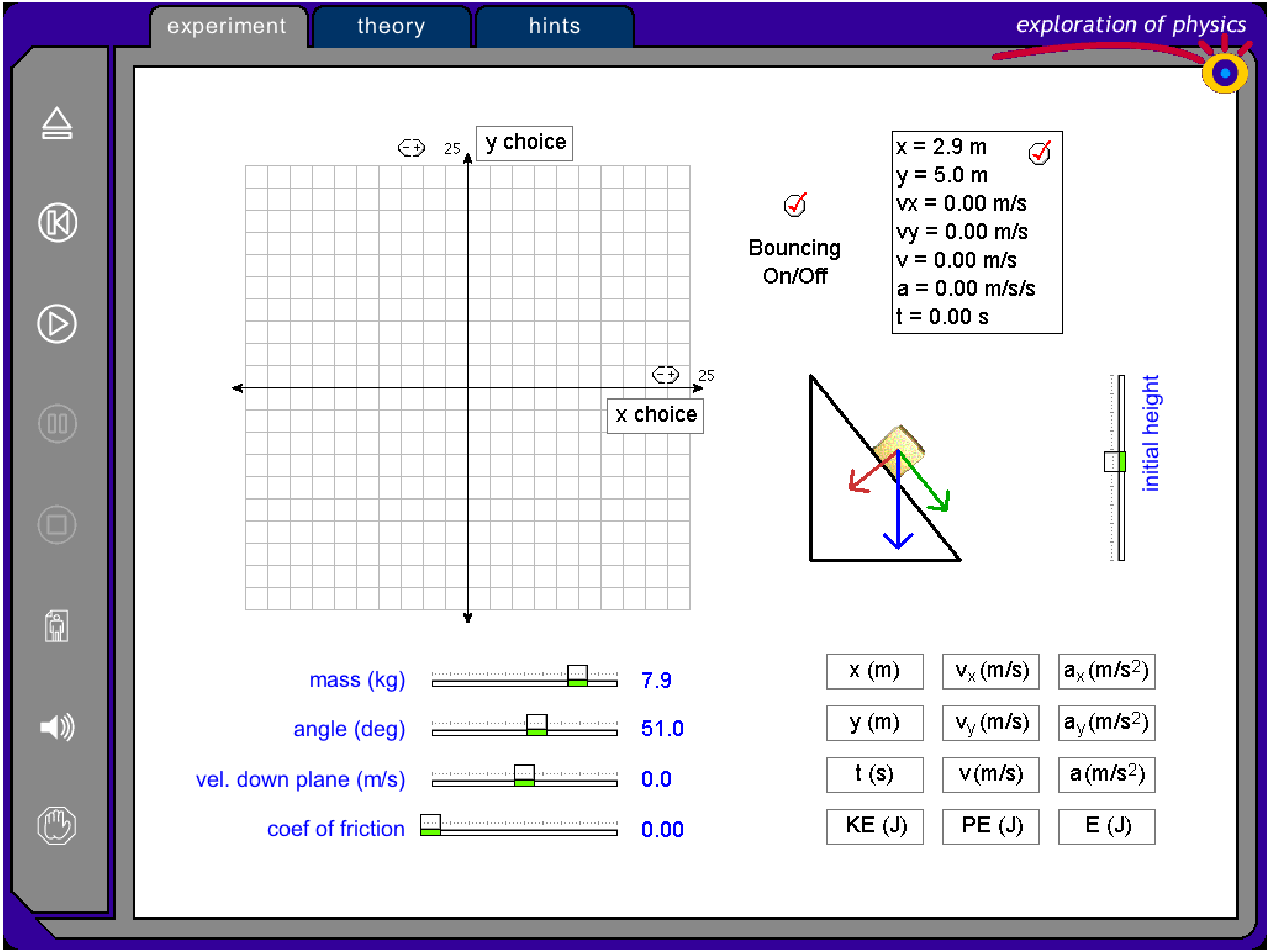
Free Fall Laboratory



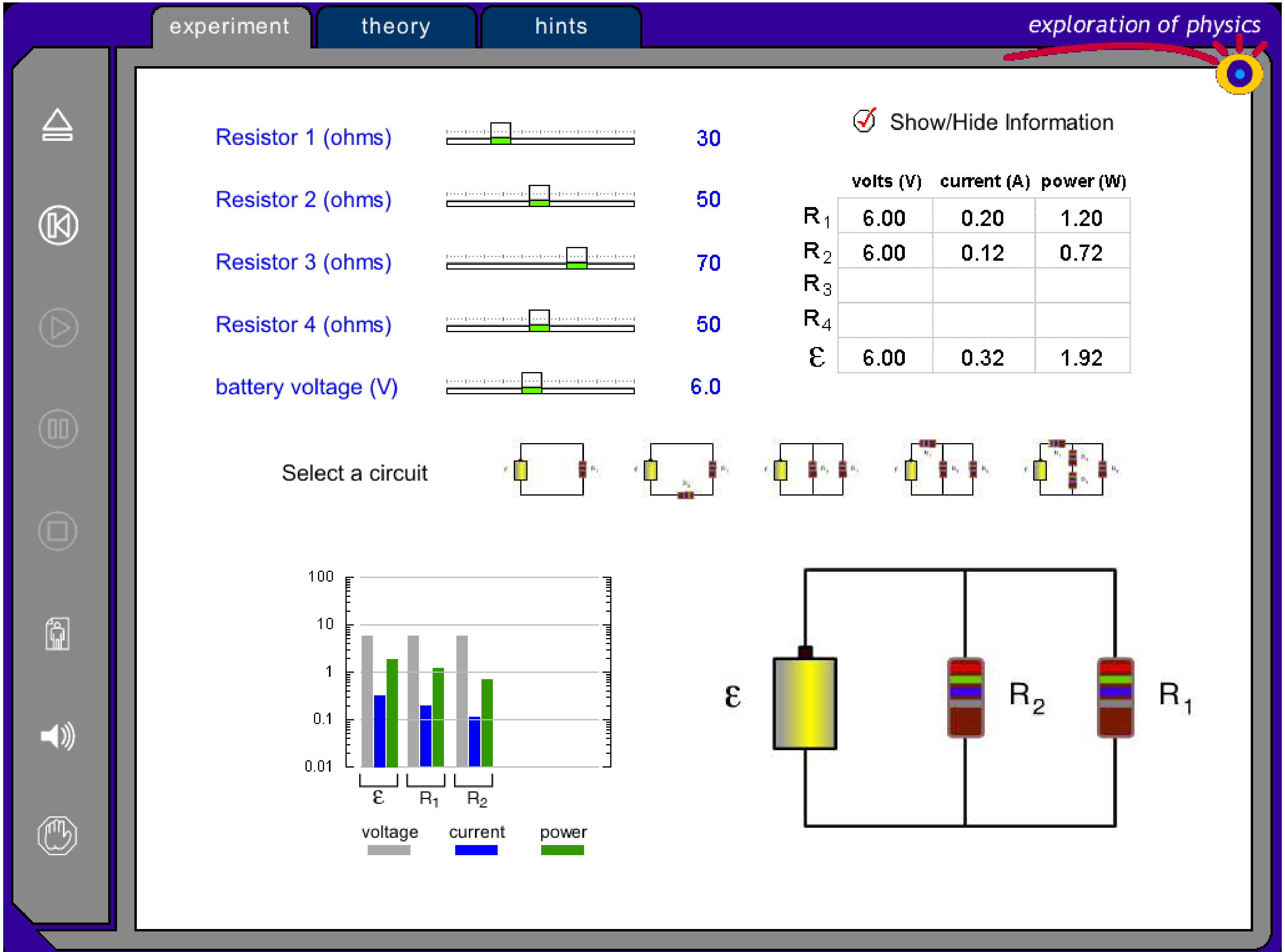
Projectile Motion



Inclined Plane

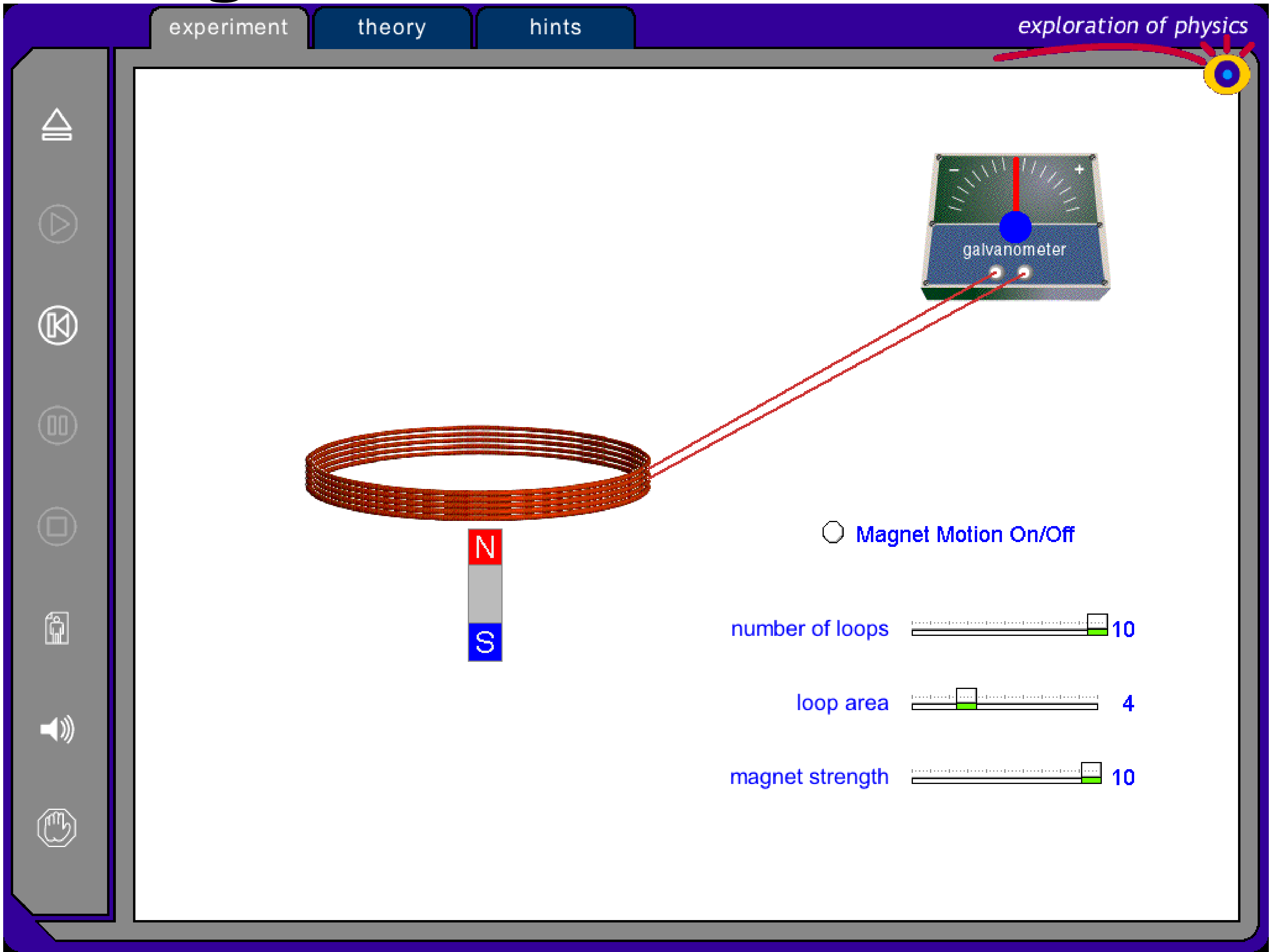


Electric Circuits



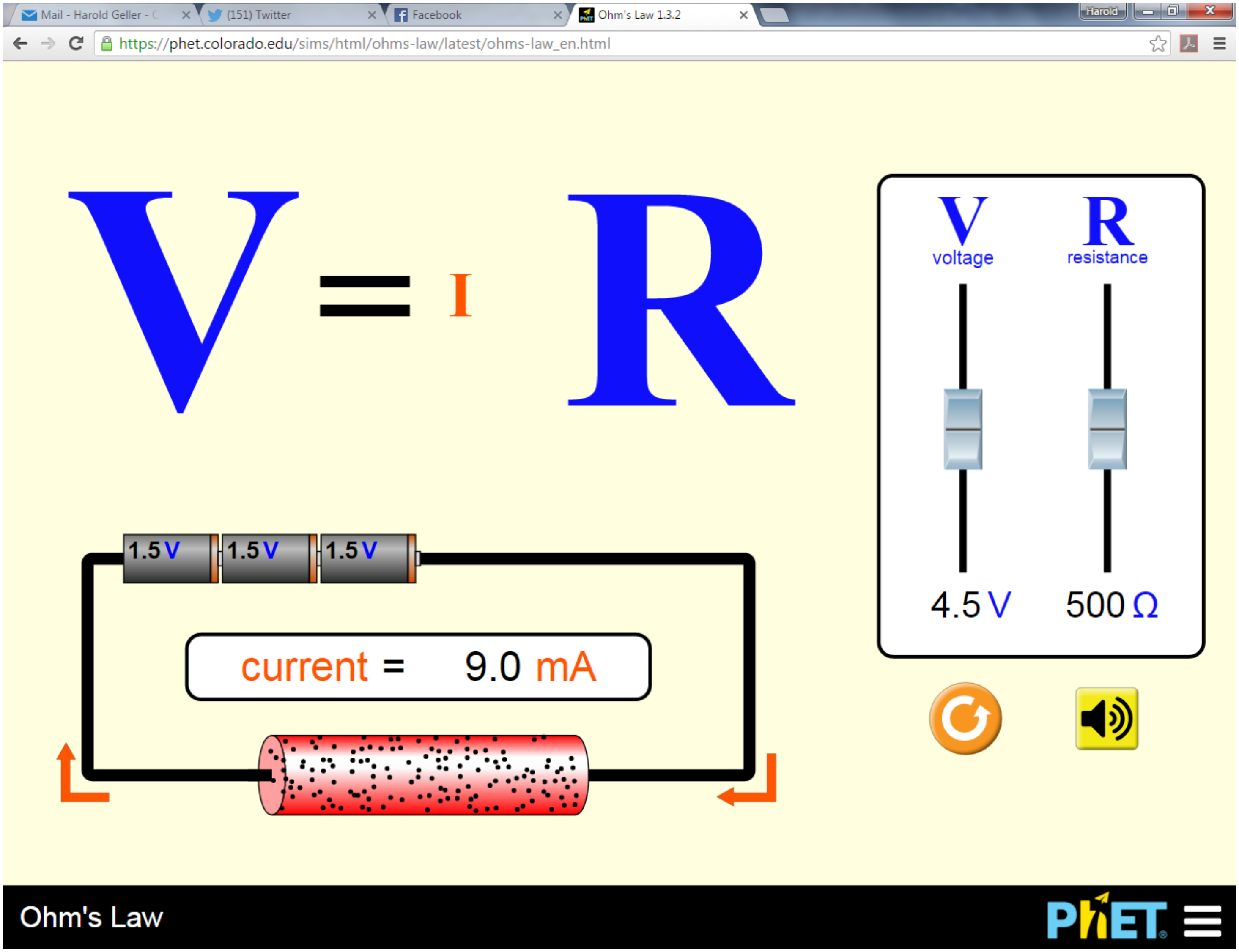
	volts (V)	current (A)	power (W)
R_1	6.00	0.20	1.20
R_2	6.00	0.12	0.72
R_3			
R_4			
ε	6.00	0.32	1.92

Magnetism and Lenz's Law

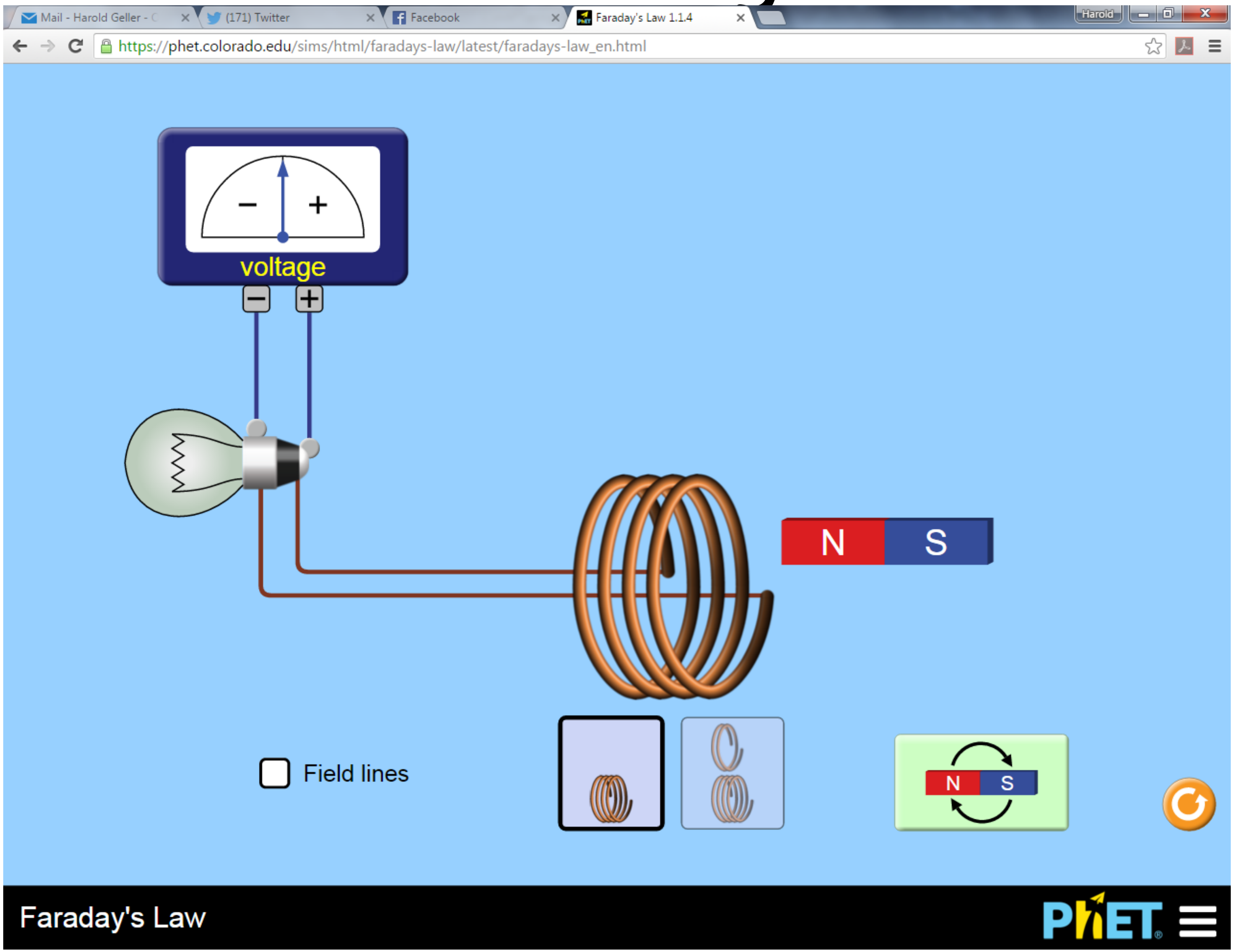


PhET for Mechanics

PhET for Electricity

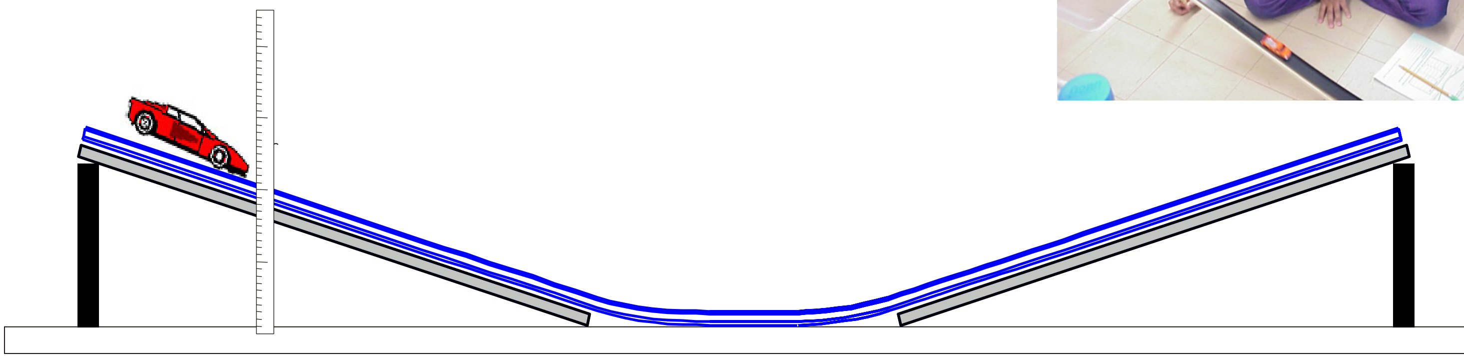


PhET for Magnetism



Activity with Half Ball and Hot Wheels

Bounce
"half" ball

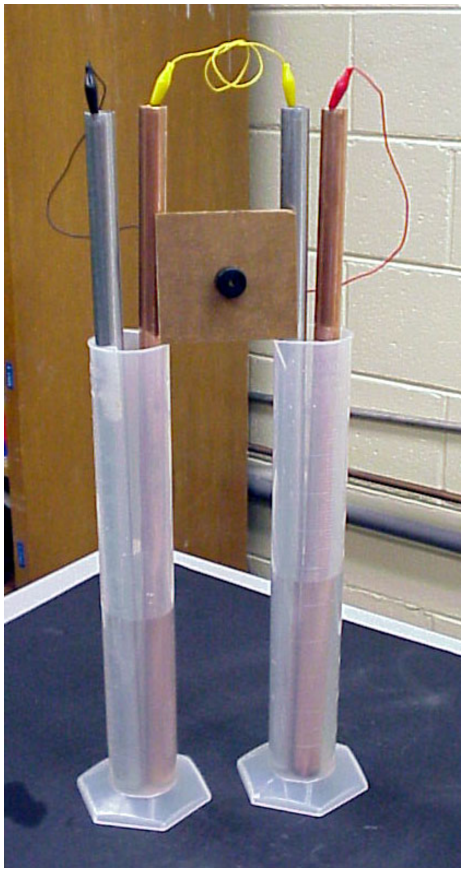


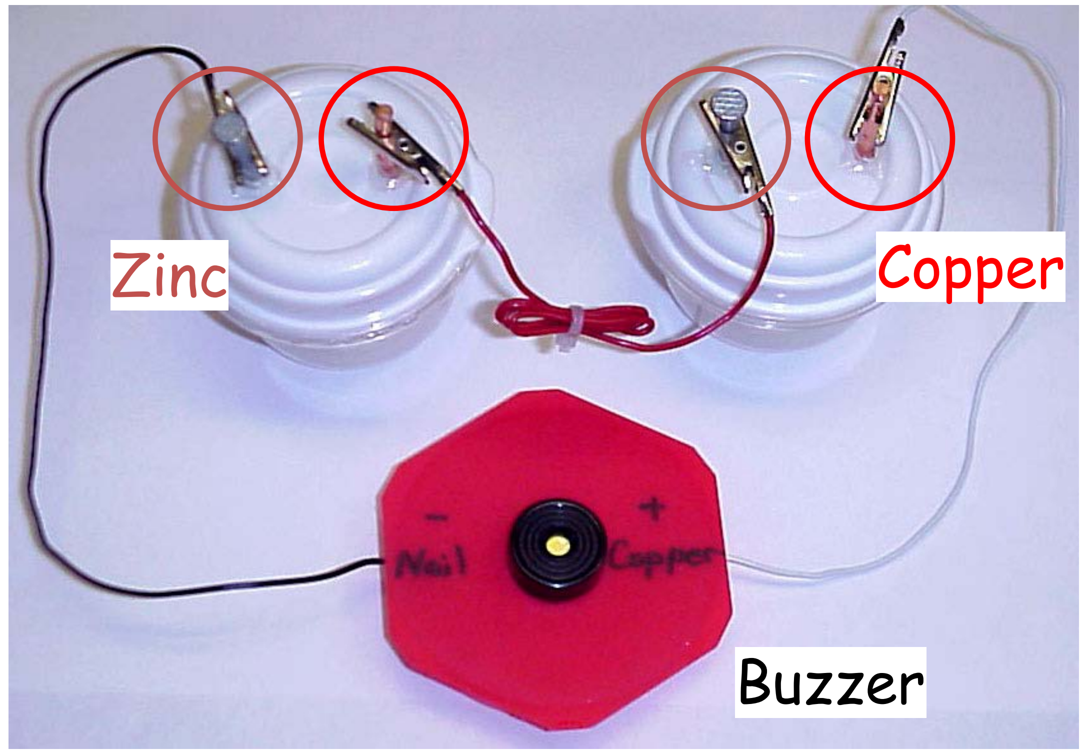
Beginning
Height

Measure Ending Height

- Develop teamwork, graphing, and prediction skills.
- Measure beginning and ending heights of released car to discover loss of energy.

Activity with Salt Battery

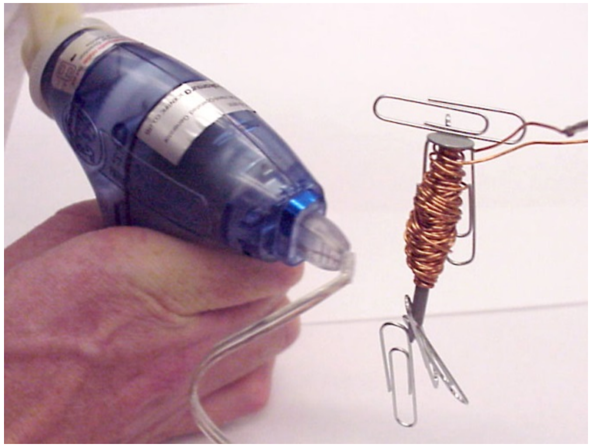


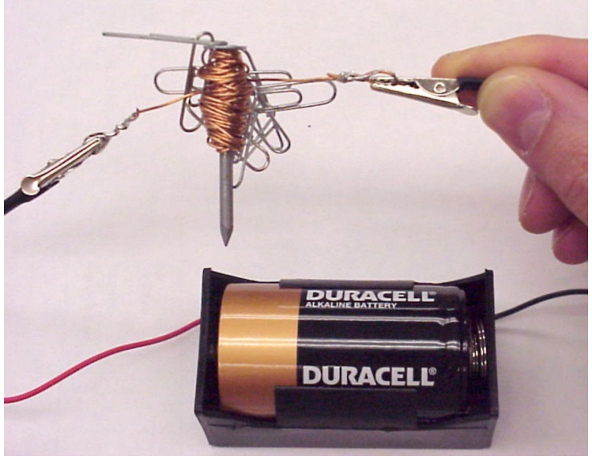


- Construct salt-water battery using copper and zinc electrodes to make buzzer work!

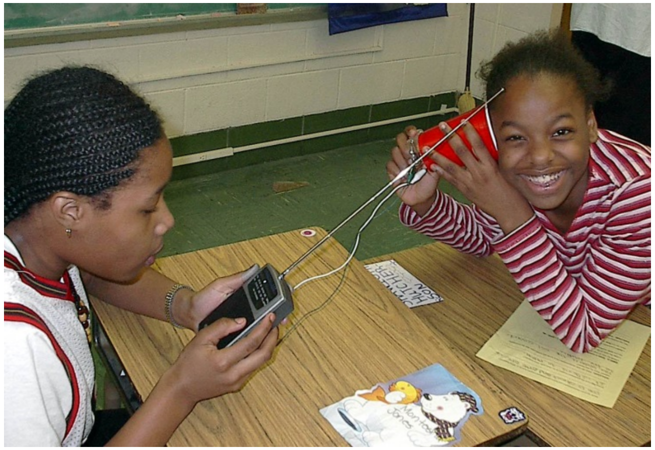
Activity with Electromagnets

Mini-electromagnet





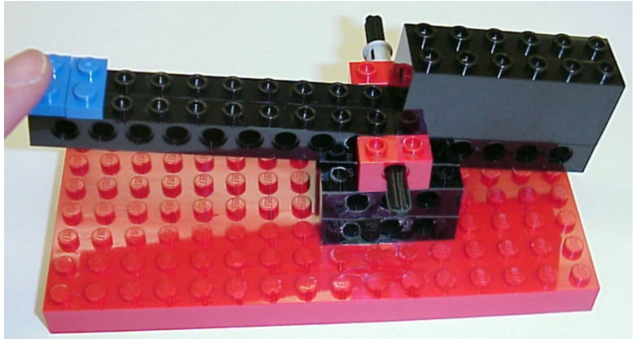
Loudspeaker



- Make electromagnet with wire wrapped around nail and "power" with generator or battery.
- Make loudspeaker using electromagnet, cup, and radio.

Activity with Simple Machines

Pulley System

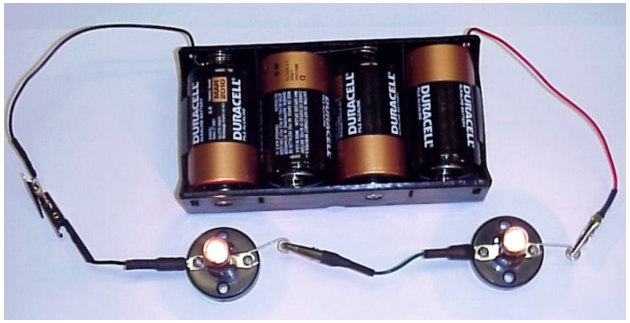


Construct Lego Lever

Identify Tools as Simple Machines

Activity with Electrical Circuits

Series Circuit



Parallel Circuit

- Build series and parallel circuits with lightbulbs and measure voltage using a meter.
  - What happens when one bulb is unscrewed?
  - Which bulbs are brighter?

Activity with Magnets

- Predict whether items are magnetic or not.

- Draw magnetic "field" lines formed by iron filings around a magnet.

Published Comments

- "…this study provide[s] evidence of the advantages of computer-based practical classes over traditional ones…"
- "…both virtual and physical manipulatives can be effective in developing conceptual understanding."
- "…school laboratory activities have special potential as media for learning that can promote important science learning outcomes for students…"
- "Researchers must examine the goals of science teaching and learning with care to identify optimal activities and experiences from all modes of instruction that will best facilitate these goals."
- "…there is no simple answer to the dilemma which laboratory is the best…"
- "Perhaps with the proper mix of technologies we can find solutions that meet the economic constraints of laboratories…while at the same time providing enough open-ended interaction to teach design."

Summary and Conclusion

- Hands on; remote; or computer simulation labs
- What is best for the money?
- What is best for the teacher?
- What is best for the students?
- Is all of physics just a computer simulation?
- At times, administrators only hear what they want to hear
- FINAL THOUGHTS
  - Would you want a surgeon who only did computer simulated surgery?
  - Or someone who only worked with virtual diapers?
  - BEWARE COMPUTER INDUSTRIAL COMPLEX

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- "Hands-On, Simulated, and Remote Laboratories: A Comparative Literature Review" by Ma and Nickerson
- "Comparing the influence of physical and virtual manipulatives in the context of the Physics by Inquiry curriculum: The case of undergraduate students' conceptual understanding of heat and temperature" by Zacharia and Constanitnou