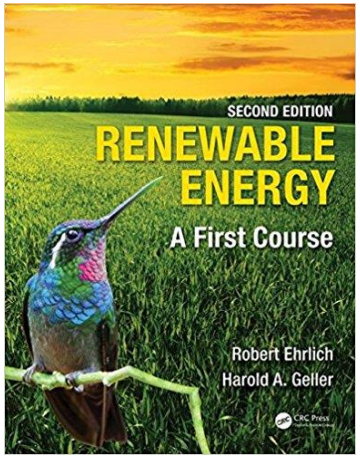

Chesapeake Section

The Physics of Energy: Non-renewable and Renewable

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GEORGE MASON UNIVERSITY

Abstract

We will discuss the many issues of the teaching of the concept of energy especially related to the modern issues of energy and the environment. We will examine some hands-on demonstrations that were used in a classroom environment; and, the misconceptions that arise in the minds of students related to the concept of energy.

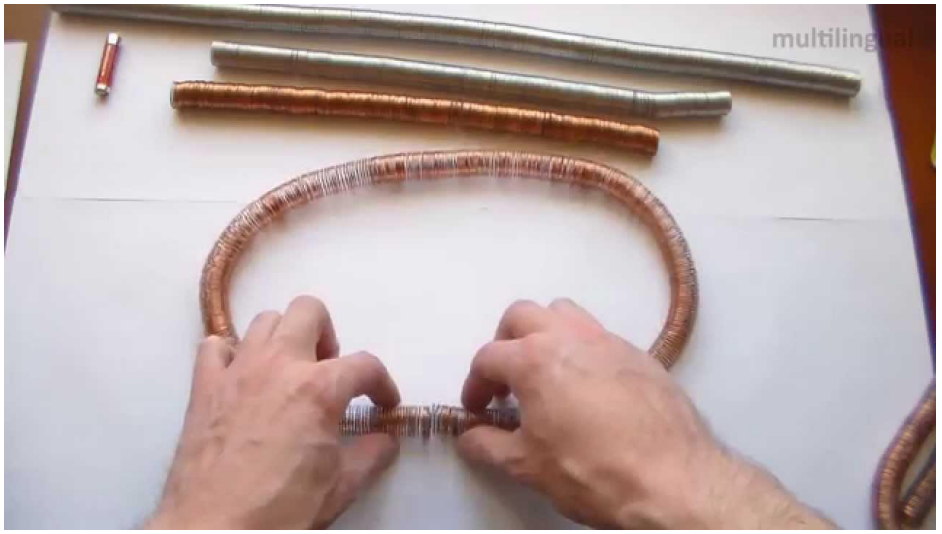
Reflection Question

What first got you interested in science?

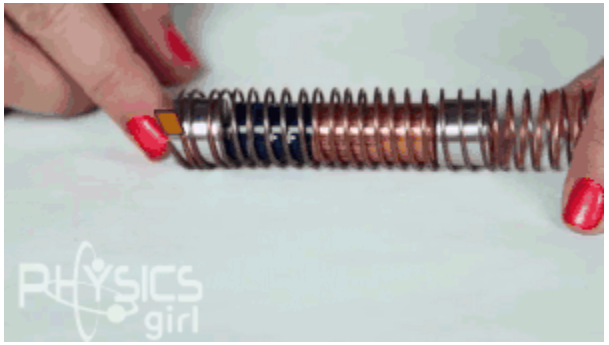
My Personal Reflection

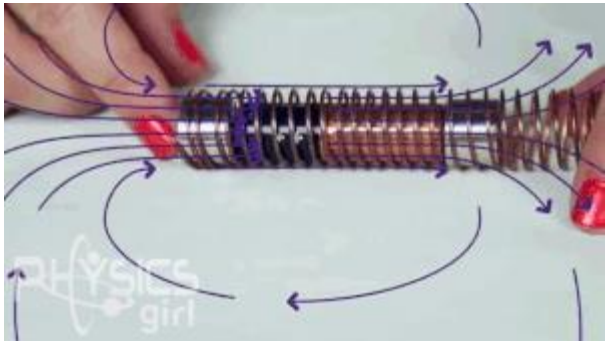
- I still recall my father giving me two strong magnets.
  - He demonstrated how difficult it was to push them together unless they were the opposite poles.
    - I tried to tell how it was that I could not push them together, easily.

So Let's Try These



Look's Easy, Right?





But Is It Really?

Physics Concepts in Renewable Energy

- Fundamental concepts of energy
  - Nuclear Fission; Nuclear Fusion
- Measurements and units of energy
- Energy sources
  - Solar energy; Hydroelectric power; Wind power; Ocean thermal energy conversion; Geothermal power; Tidal energy; Wave energy; Nuclear energy
- Nuclear weapons
- Thermodynamics
  - Energy conservation
- Modes of transportation
- The atmosphere
  - Ozone layer
  - Greenhouse Gas Effect

Physics Education Research Findings

- **Textbooks present a fragmented and sometimes misleading view of energy.**
  - **Energy is said to be "invented," and "abstract."**
  - **Energy can be "converted" to different "forms."**
- **"Students do not find energy to be very useful, even for prototypical school science phenomena."**

Physics Education Research Findings

- **"National science standards present a problematic view of energy."**

  From the opening sentence of the energy section in the AAAS/Project 2061 Standards:

  "Energy is a mysterious concept…."

Physics Education Research Findings

- **Students have an incoherent view of energy.**
  - **Potential energy is often ignored.**
    - **"Just a number"**
    - **"An invented quantity"**
    - **Potential energy is not *actual* energy.**
    - **It often is thought to have nowhere to exist, so it cannot really exist.**

Physics Education Research Findings

- Students have an incoherent view of energy.
  - Energy can be "produced."
  - Energy conservation only weakly constrains student thinking. It does not force inferences.
- Energy is not *useful* to students in describing and explaining natural phenomena.
  - Often have to be prompted even to invoke it!

Recommendations

- **Energy should be presented as a single concept.**
  - **Energy does not come in different "forms." It is only stored in different things.**
  - **There is only one kind of energy: Energy**

Main Concepts For Understanding Energy

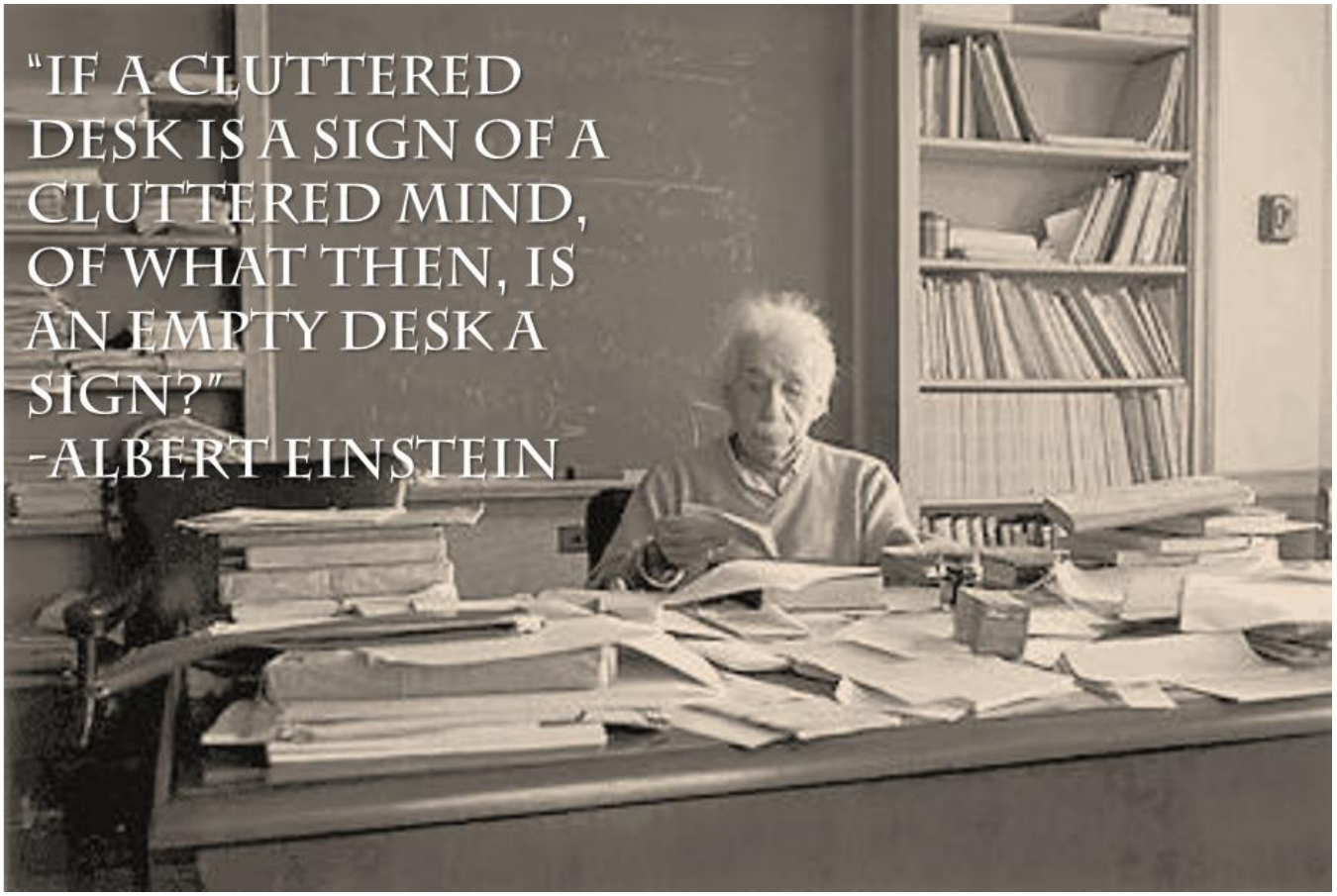
- Work
- Potential Energy
- Kinetic Energy
- Conservation of Energy
- Types/Sources of Energy

Question for Thought

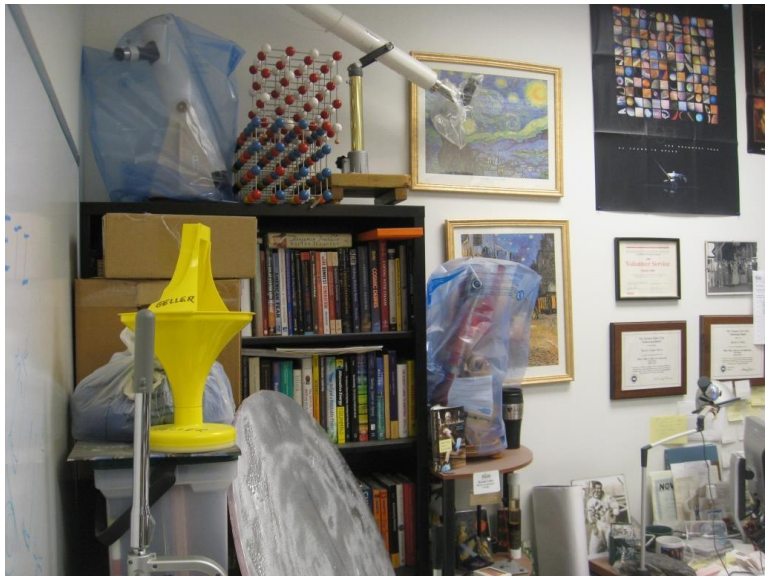
- If energy cannot be destroyed, why do some people worry about the energy supplies?

- Energy is eventually converted into unrecoverable radiant energy, so new sources of convertible energy must be found in order to continue performing useful work.

Remember What Einstein Said

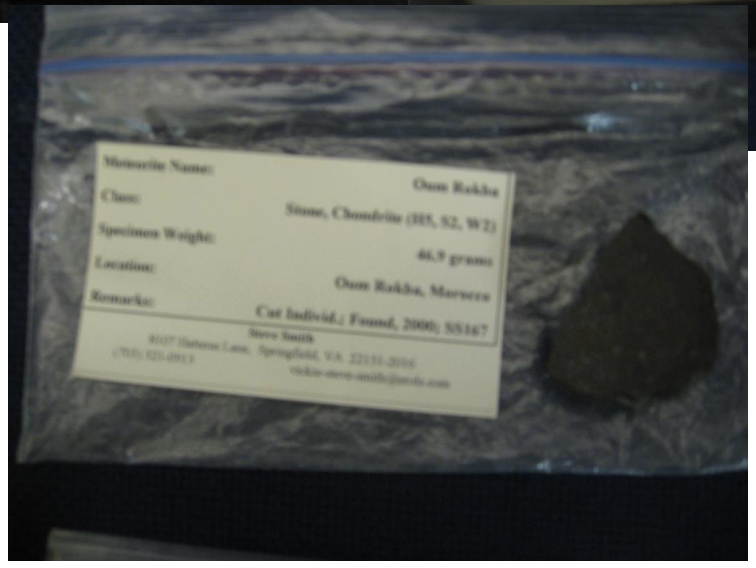


Yes, I have a Cluttered Office

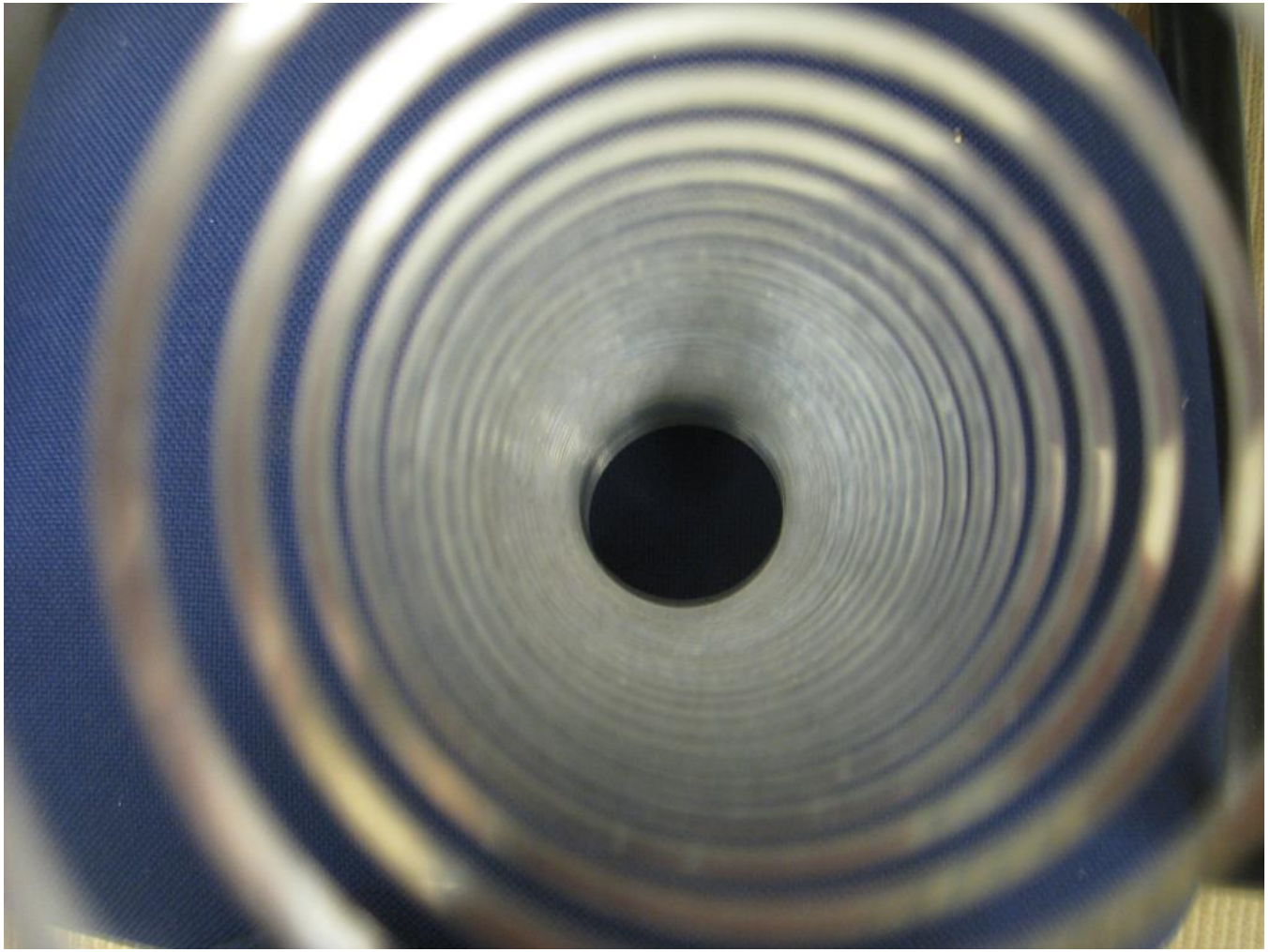


Touch It, Feel It, Smell It

From Asteroids to Mars



What is this?



Now You Know

A Slinky – it can be used to demonstrate

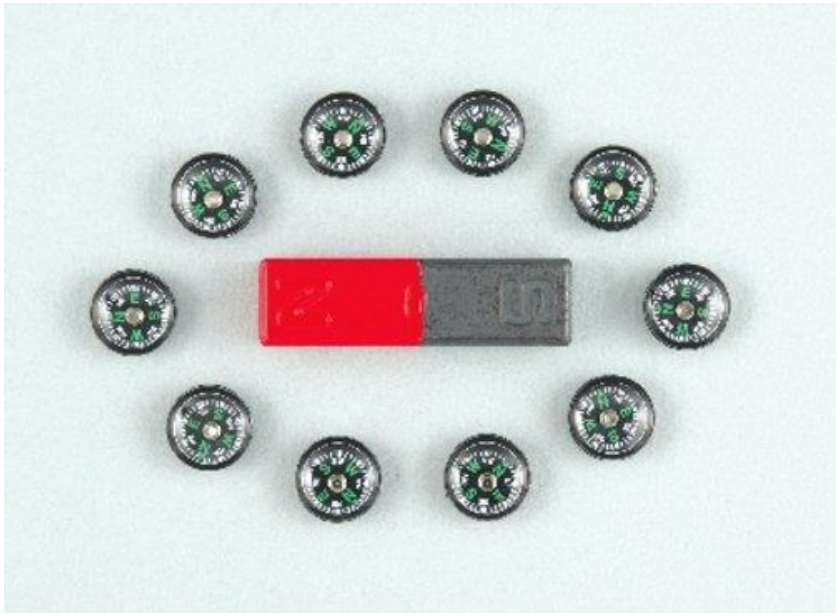
- Longitudinal Waves
- Transverse Waves
- Standing Waves
- Hooke's Law (springs)

Demonstrate From Newton's Third Law to Supernova Explostion

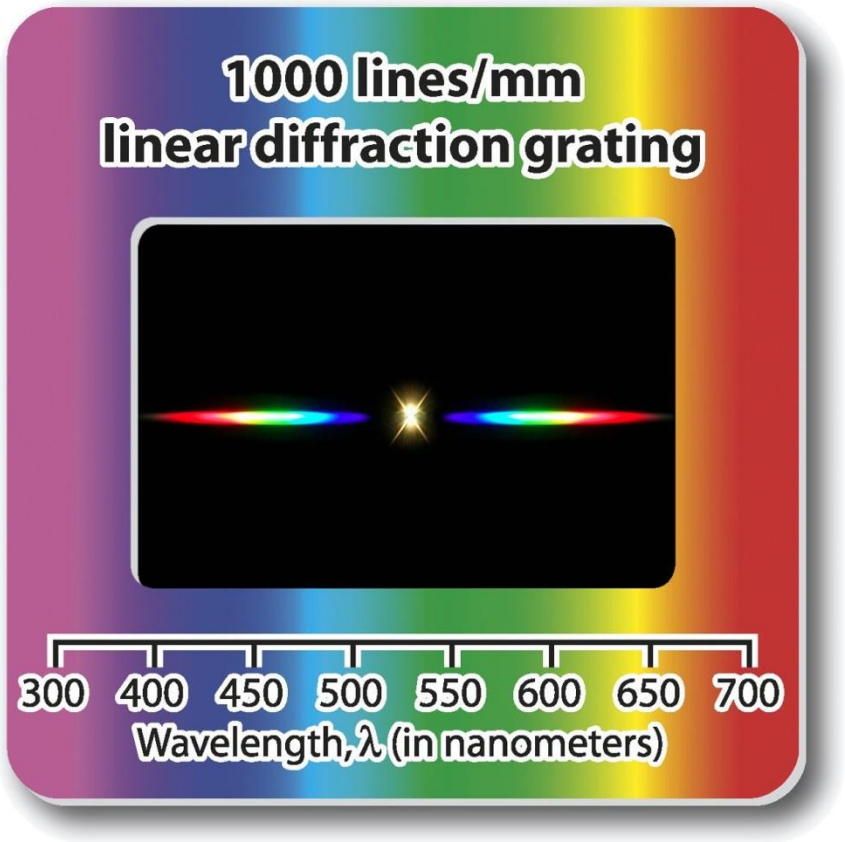
Supernova (balls on a stick) can be used to demonstrate

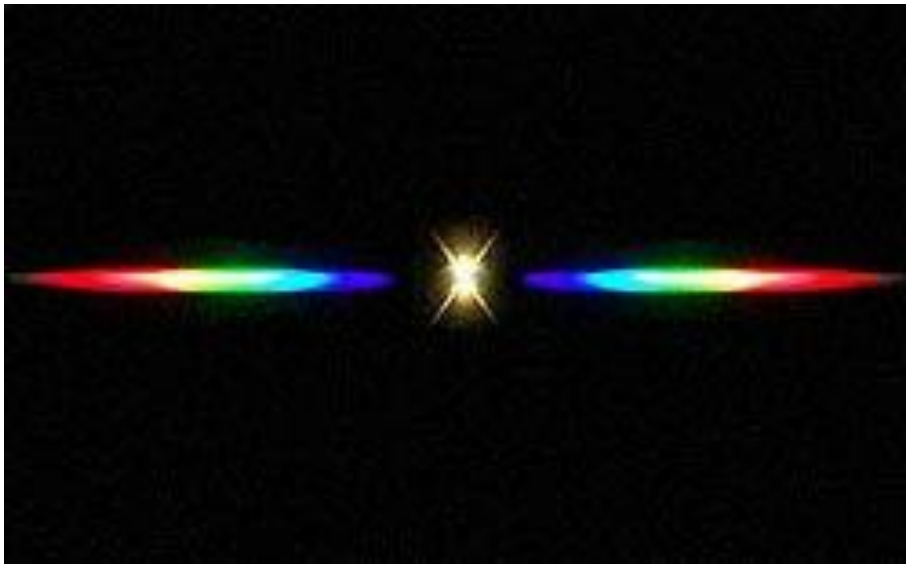
- Supernova collapse and explosion processes
- Newton's Third Law
- Conservation of Energy

Magnets



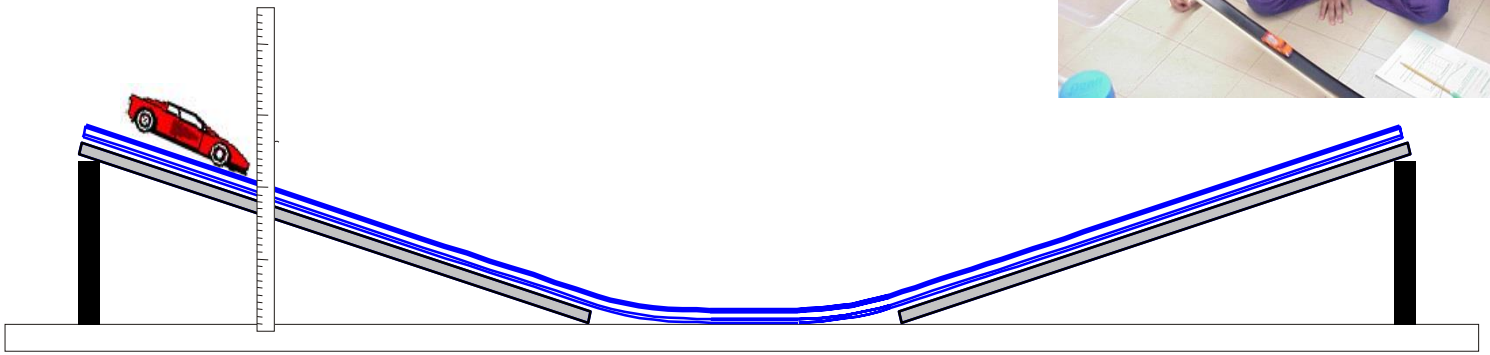
Diffraction Grating





Activity with Half Ball and Hot Wheels

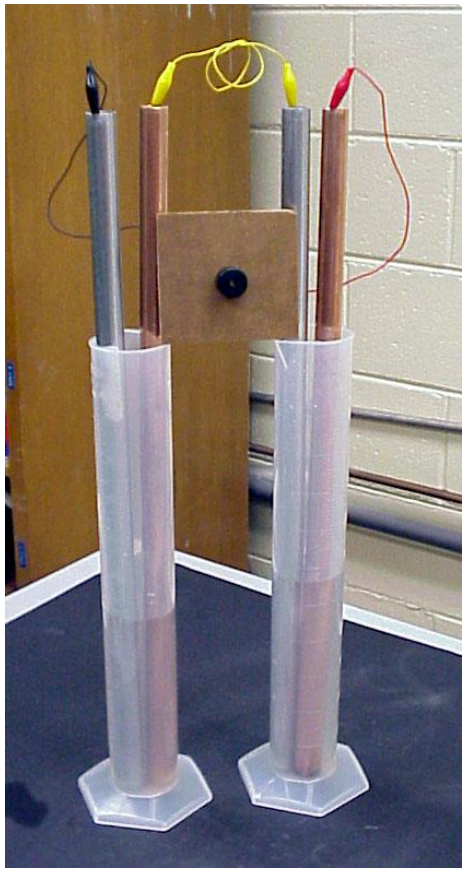
Bounce
"half" ball

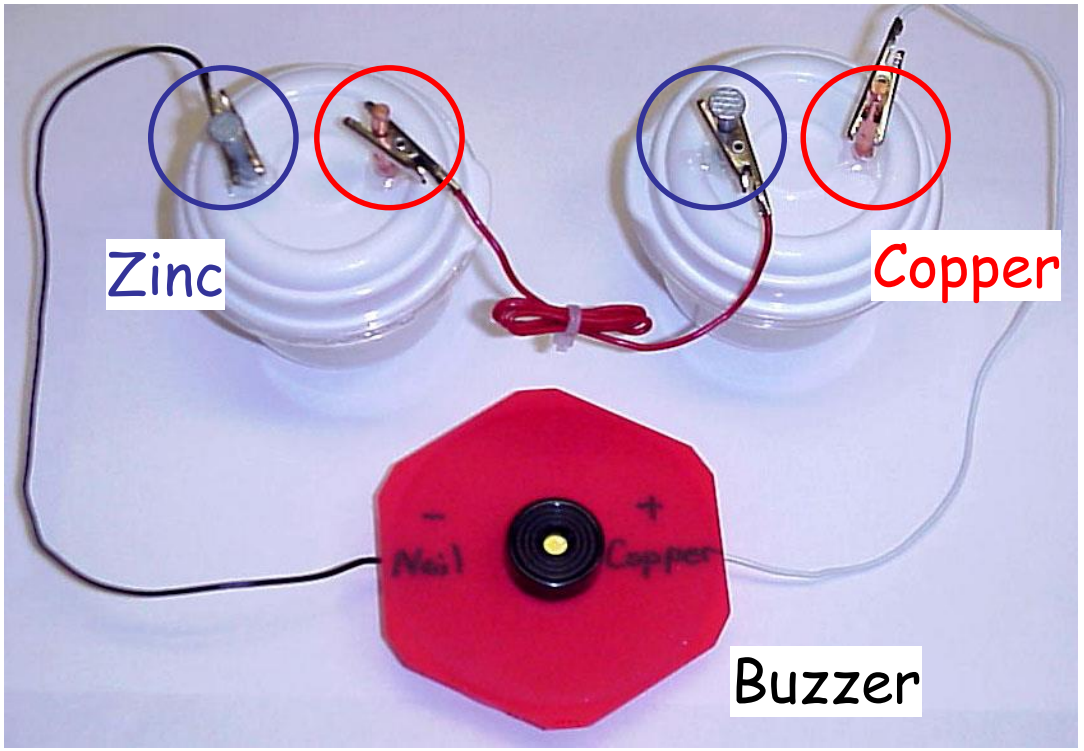


Beginning
Height

Measure Ending Height

Activity with Salt Battery

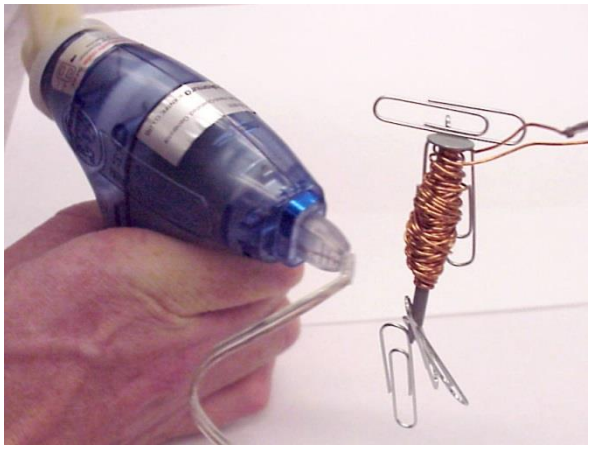


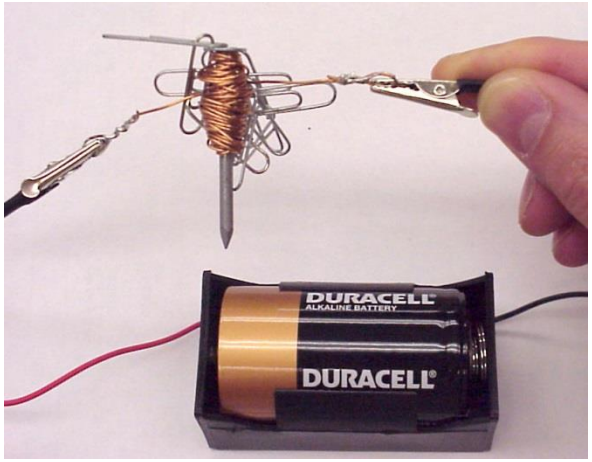


- Construct salt-water battery using copper and zinc electrodes to make buzzer work!

Activity with Electromagnets

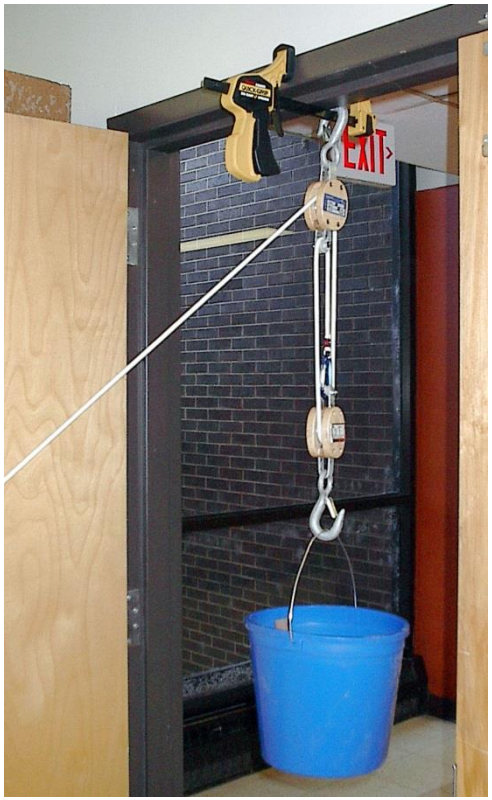
Mini-electromagnet



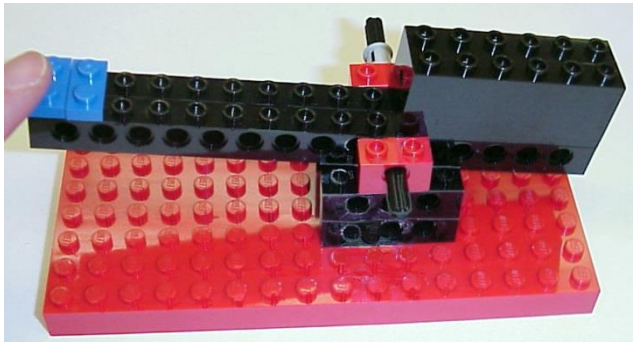


Loudspeaker

Activity with Simple Machines



Pulley System



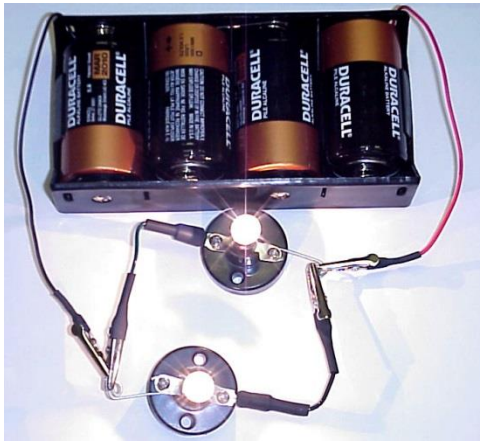
Construct Lego Lever

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.

Now for Some Hands-On Activities

Using One Wire, a Battery, and a Bulb – Light the Bulb [sketch here first!]

What Research Has to Say

- Ma and Nickerson (2006)
  - *ACM Computing Surveys* 38(3)
- Corter, Nickerson, Esche & Chassapis (2004)
  - Frontiers in Education, 34th
- Kennepohl (2001)
  - Int'l J. of E-Learning and Distance Education 16(2)
- Davis, M. R. (2009)
  - *Education Week*, *2*(4)
- Zacharia, Z. (2003)
  - Journal of Research in Science Teaching, 40(8)

Education Research References

- Sterling, D., J.J.Matkins, W.M. Frazier, M.G. Logerwell (2007)
  - *School Science and Mathematics*, 107(4).
- Ma and Nickerson (2006)
  - *ACM Computing Surveys*, 38(3)
- Corter, Nickerson, Esche & Chassapis (2004)
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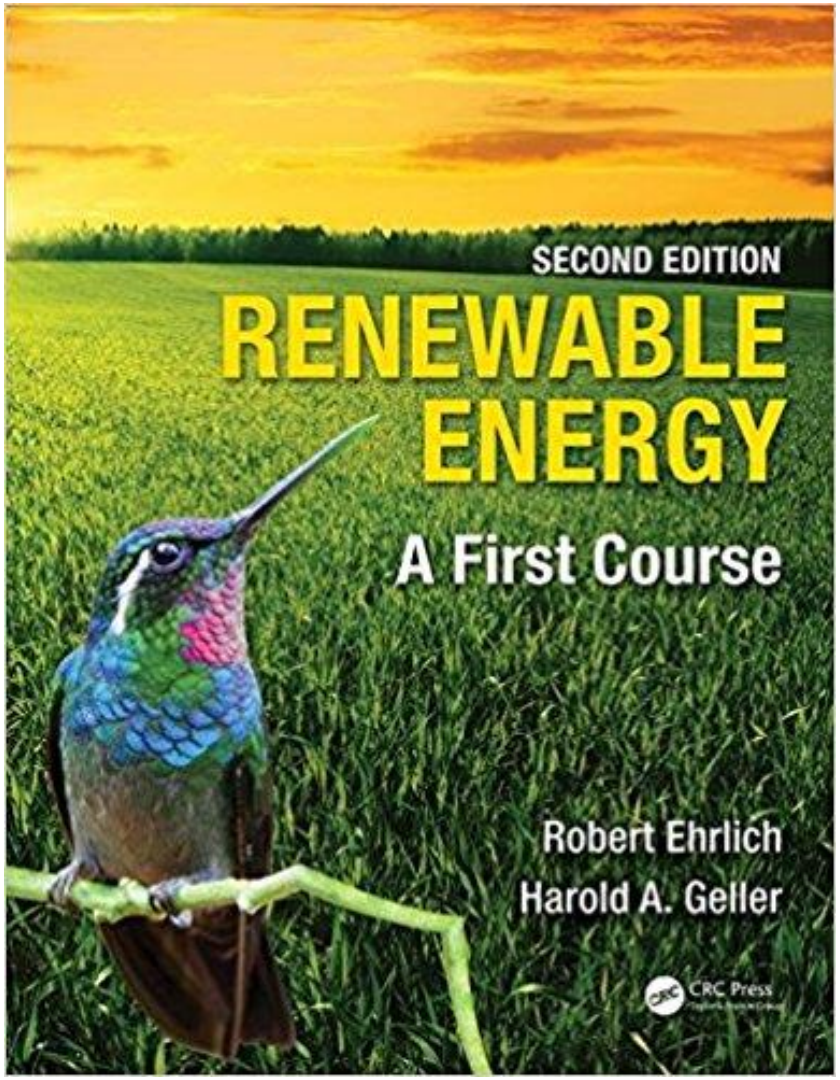
Renewable Energy Textbook



- First edition
  - 2013
    - Robert Ehrlich
- Second edition
  - January 2018
    - Robert Ehrlich
    - Harold Geller

Acknowledgements

- The students of HNRT 228 Energy and the Environment
- The students of HNRS 353
- Students of PHYS 331, 581 and 631
- Graduate Teaching Assistants
  - Prabal Saxena
  - Anne Crowell