



Engaging Students in
Common Core Courses—

**Arousing Their Interest
and Managing Their
Expectation**

Dr. NG, Yee Fai
Physics Department

- * PHYS 1001
Physics and the Modern Society
- * PHYS 1005
Physics in Movies

+ Some Teaching Methods

1. Text: Quotations

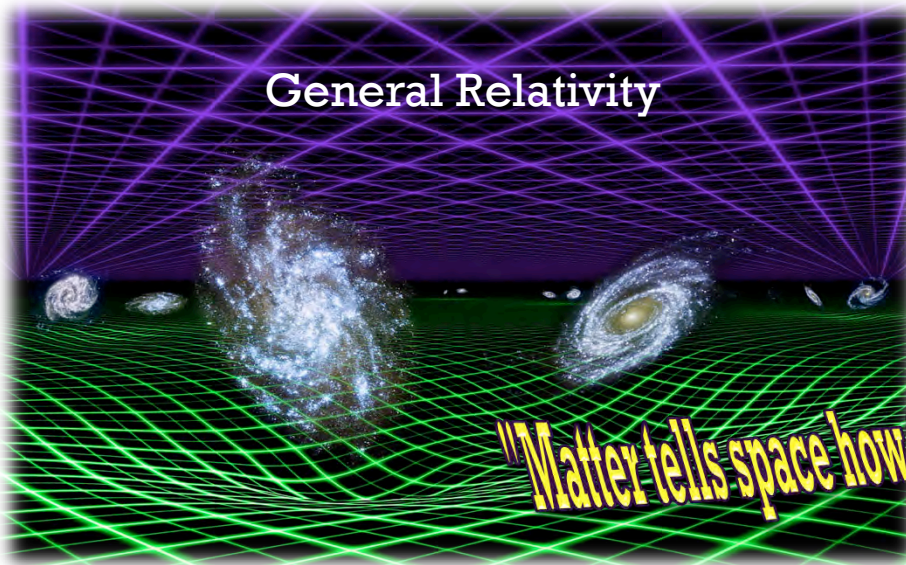
- Famous scientists' words of wisdom could deepen the understanding of a subject.

We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology.

~ Carl Sagan (1934-96)



<http://blogs.agu.org/wildwildscience/files/2010/12/Carl-Sagan-1.jpg>



General Relativity

"Matter tells space how to curve, and space tells matter how to move."
~ John Wheeler (1911-2008)

http://cdn.physorg.com/newman/gfx/news/hires/2011/artwork_darkenergy-sm.jpg

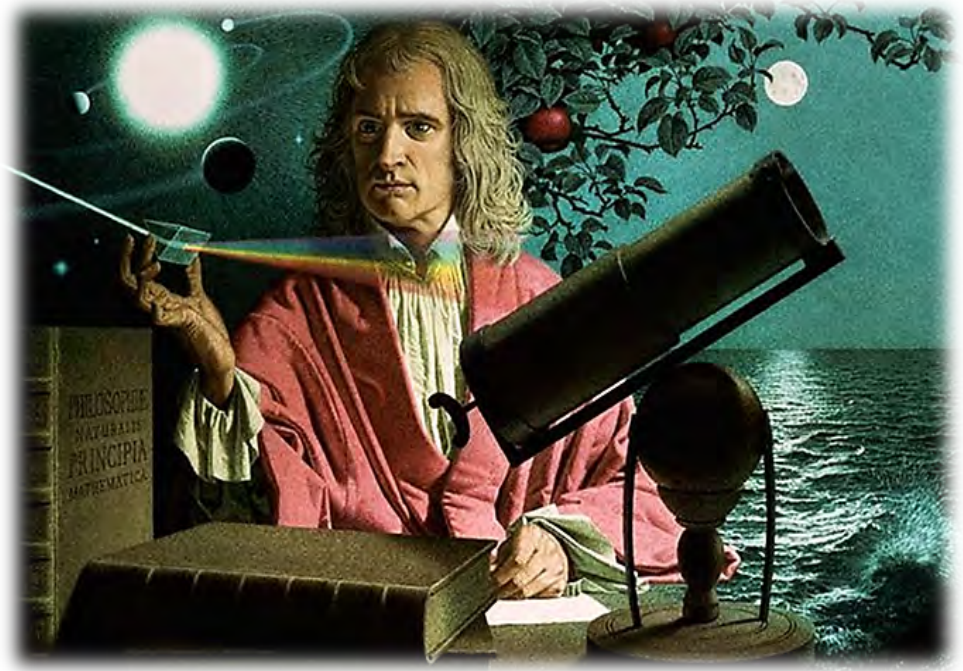
+ Some Teaching Methods

1. Text: Biographies

- Give brief accounts of achievements and amusing anecdotes of physics giants.
- Help realize scientific developments.

Sir Isaac Newton (1642-1727)

English physicist and mathematician. Isaac Newton was a contentious genius who made extraordinary strides in mathematics, optics, mechanics and gravitational attraction. He invented calculus, explained the colors of the rainbow, and realized that the same gravitational force giving us weight also controls the movements of the Moon and planets.



+ Some Teaching Methods

1. Text: Wording

- Keep concise and clear—less is more.

From PHYS 1001 & PHYS 1005 lecture notes:

6. Elastic Collision

An (perfectly) **elastic** collision is a collision in which the total **kinetic energy** (K.E.) of a system of colliding bodies is **conserved** (no change). However, the K.E. of each colliding body may change.



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Movie Scenes Violating Laws of Physics: Analysis

2001: A Space Odyssey (1968)



Just before Dave exits the pod.



Just after Dave exits the pod.

By Newton's third law (action and reaction), the pod should **jerk back** when the door of the pod, the air inside the pod, and Dave are expelled out of the pod (because of pressure difference). However, the pod **stays still** there!

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- Provide Chinese translation for important technical terms: *e.g.*, entropy (熵).

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1. Text: Equations

- Physics speaks in mathematics.
- Equations / formulae are inevitable.

Exponential decay
of radioactivity:

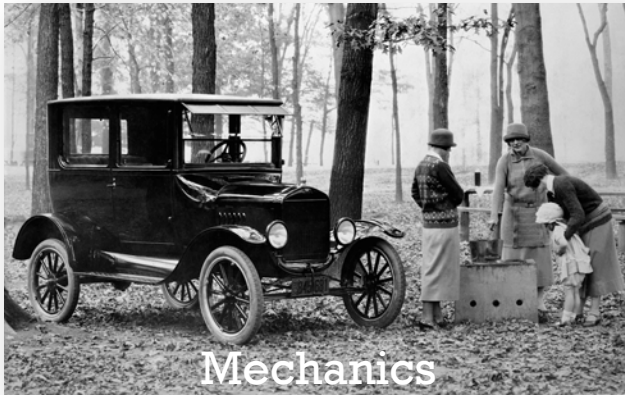
$$\left. \begin{aligned} \frac{dN}{dt} &= -\lambda N \\ \int_{N_0}^N \frac{dN}{N} &= -\lambda \int_0^t dt \\ \ln N \Big|_{N_0}^N &= -\lambda t \Big|_0^t \\ \ln N - \ln N_0 &= -\lambda(t - 0) \\ \ln \left(\frac{N}{N_0} \right) &= -\lambda t \end{aligned} \right\} \text{Optional derivation}$$

$\Rightarrow N = N_0 e^{-\lambda t}$

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2. Multimedia: Pictures

- Let pictures tell the stories.



<http://wot.motortrend.com/files/2011/07/1923-Ford-Model-T.jpg>



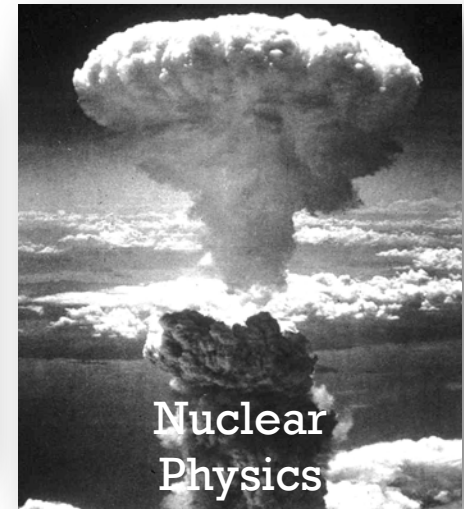
http://upload.wikimedia.org/wikipedia/commons/4/41/Space_Shuttle_Columbia_launching.jpg



http://blog.oregonlive.com/environment_impact/2009/09/coalplant.jpg



<http://cdn.c.photoshelter.com/img-get/I0000Vb0B.acqOJO/s/860/860/0907C013.jpg>



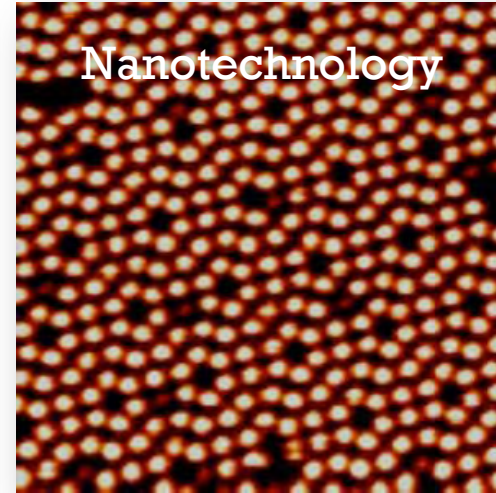
http://media.npr.org/assets/artslife/books/2010/01/bomb_custom-7c2e8b0a67a15b6205a93525c711b6d6bd4dd3512-s6-cl0.jpg

+ Some Teaching Methods

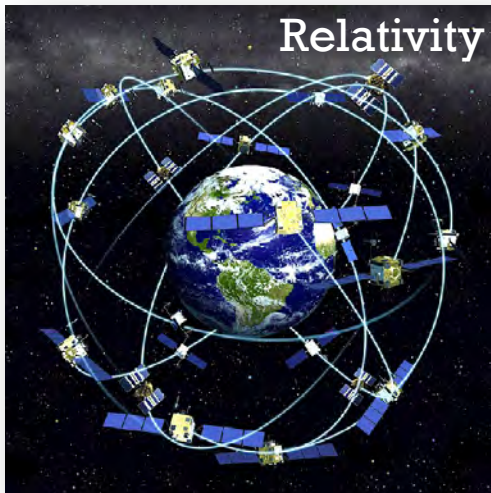
2. Multimedia: Pictures



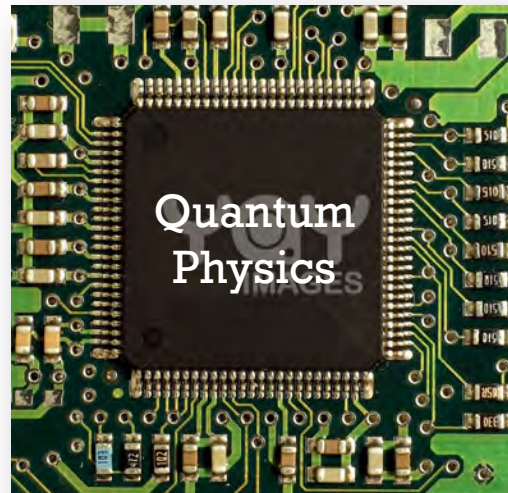
<http://cdn.zmescience.com/wp-content/uploads/2012/01/renewable-energy-02.jpg>



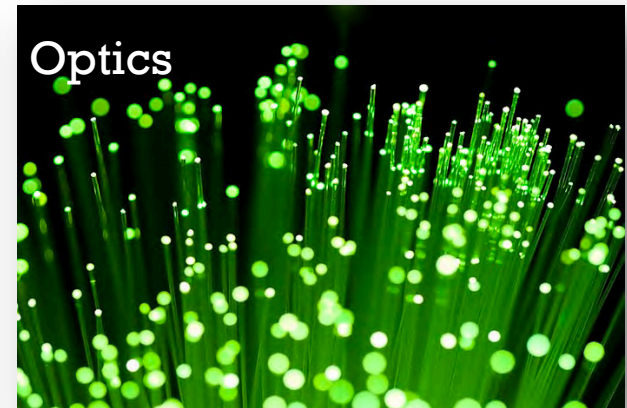
http://preview.omicron.de/results/temperature-variation-with-the-lt-stm/pic/temperature-variation-with-the-lt-stm_1_300.jpg



<http://upload.wikimedia.org/wikipedia/commons/e/e2/GPS-constellation-3D-NOAA.jpg>



<http://image.yaymicro.com/?z=1210x1210/0/850/macro-image-of-a-large-microchip-85052a.jpg>



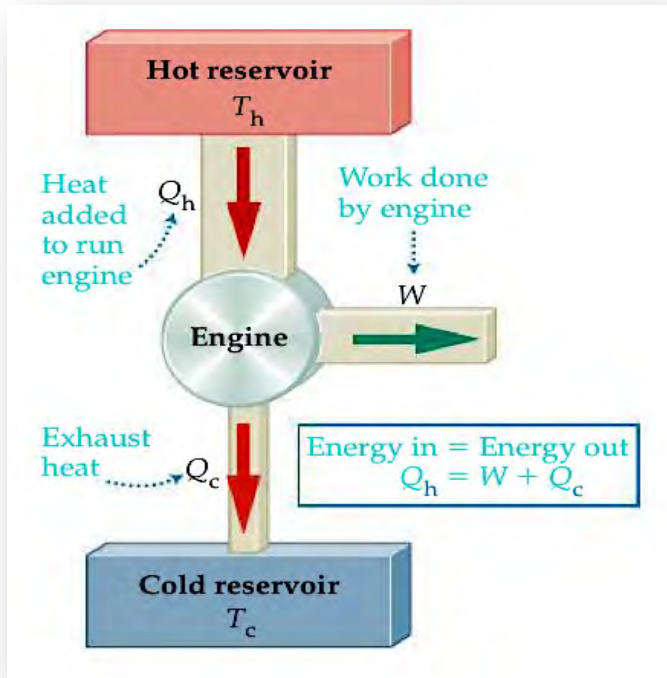
http://www.photo-dictionary.com/photofiles/list/698/1109fiber_optics.jpg

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2. Multimedia: Pictures

- Illustrative figures help understand textual materials.

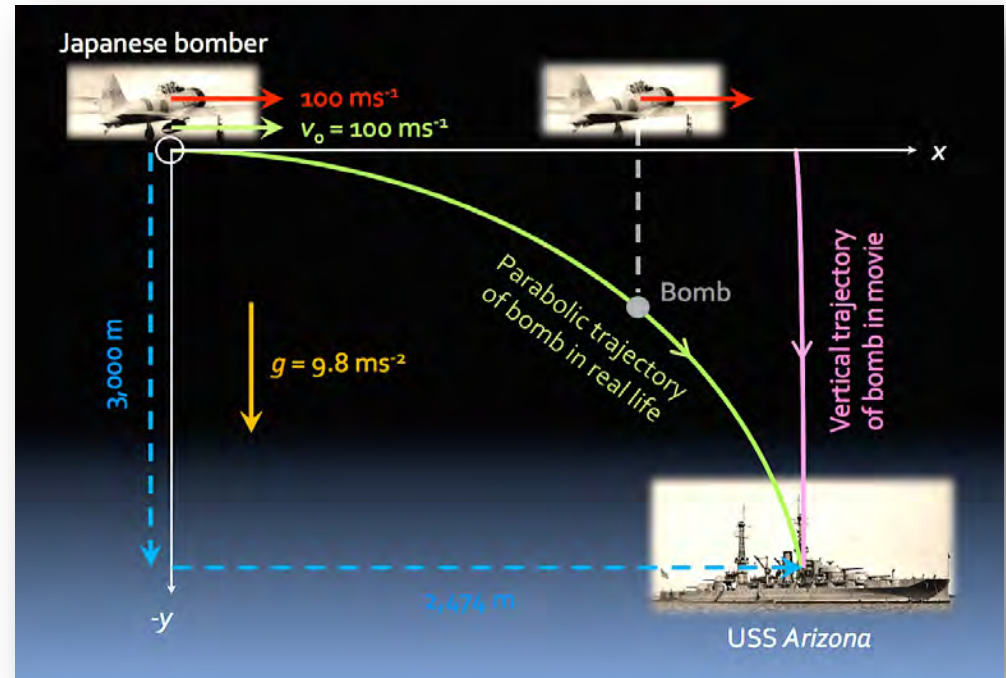
From publishers:



*Physics / 1st edition /
James S. Walker / 2014 / Pearson*

(Schematic heat engine)

Home-brewed:



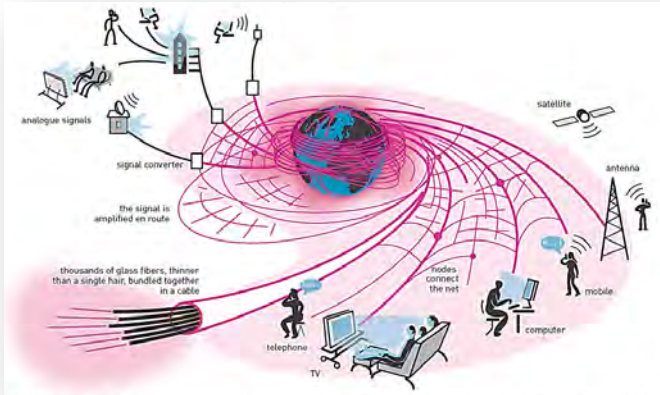
From PHYS 1005 lecture notes

(Parabolic trajectory of bombs)

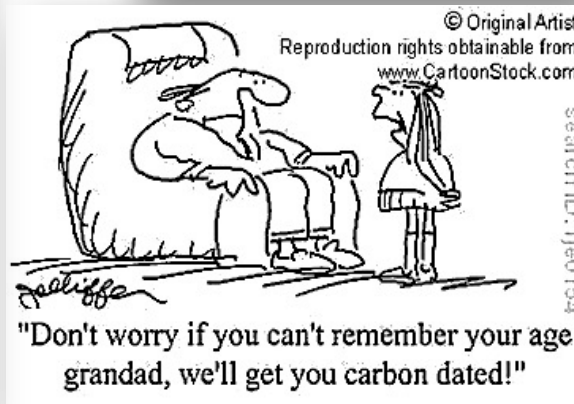
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2. Multimedia: Pictures

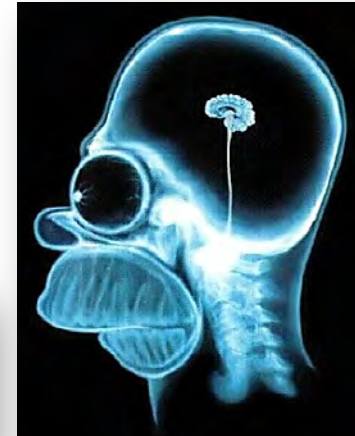
- Learn in a funny way with cartoons.



http://www.nobelprize.org/nobel_prizes/physics/laureates/2009/popular_physicsprize2009.pdf



Scan from: *Introducing Quantum Theory: A Graphic Guide to Science's Most Puzzling Discovery* / J.P. McEvoy & Oscar Zarate



<http://1.bp.blogspot.com/-vx7nwiAIGtc/UDnlWHRDydl/AAAAAAAAAfc/blnOM4Uz3rs/s1600/X-Ray.jpg>



<http://nerdnirvana.org/wp-content/uploads/2010/07/super-xray-vision.jpg>

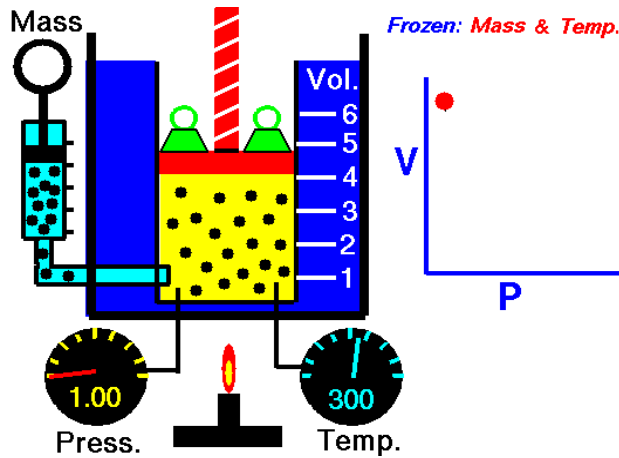
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2. Multimedia: Animation

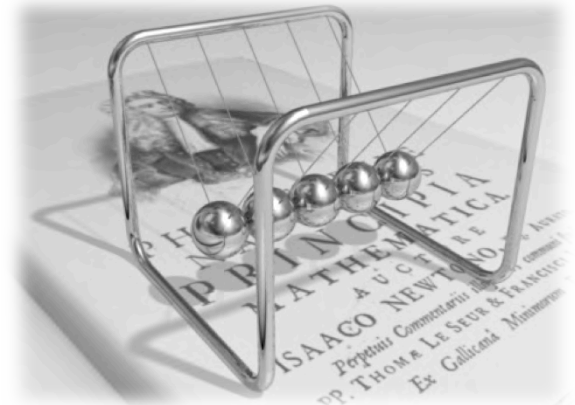
- Help depicting dynamic processes.

Newton's cradle in action:

Volume varying with pressure:

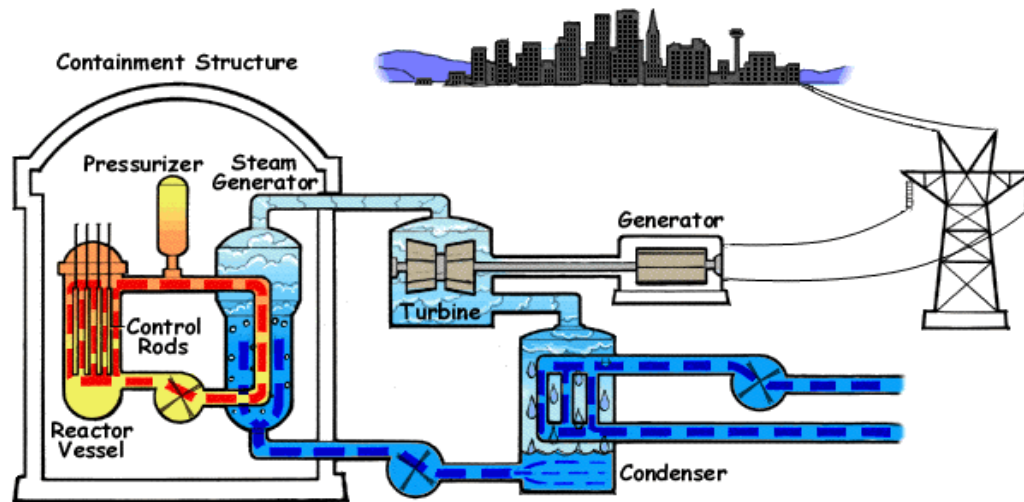


http://upload.wikimedia.org/wikipedia/commons/1/15/Boyles_Law_animated.gif



http://en.wikipedia.org/wiki/File:Newton's_cradle_animation_book_2.gif

Operating nuclear reactor:



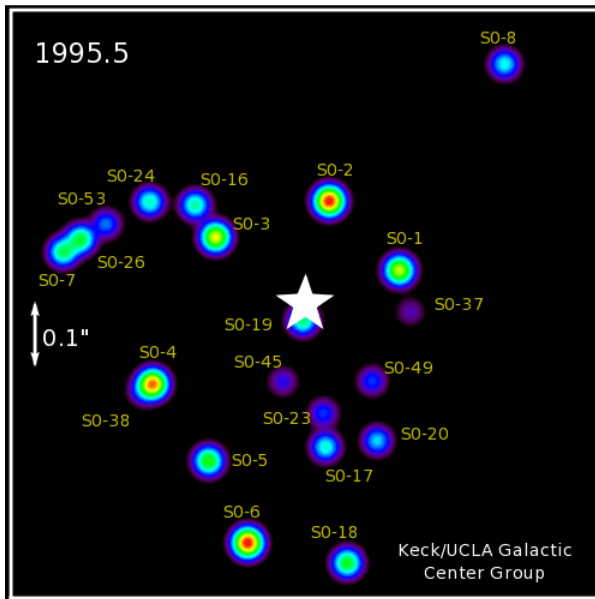
http://www.45nuclearplants.com/nuclear_reactor_designs.asp

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2. Multimedia: Simulation

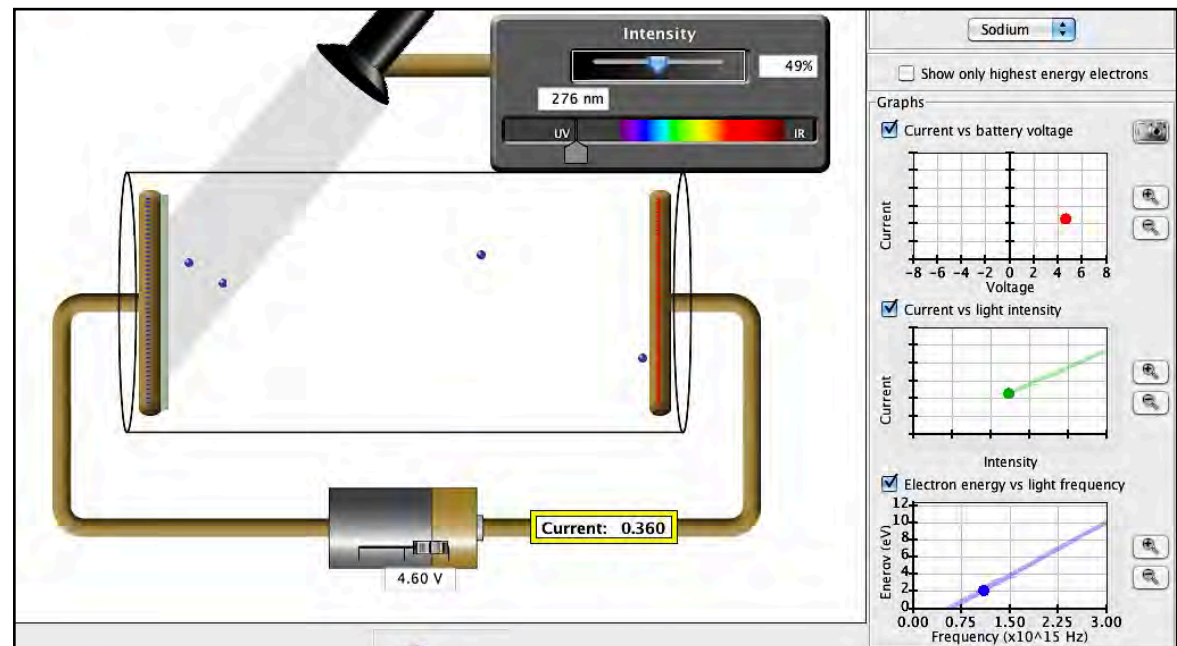
- Study in an interactive way.
- Grasp abstract concepts in a lively way.

Motion of stars around a suspected black hole:



http://www.edu-observatory.org/eo/black_holes.html

Real-time effects upon changing parameters:



<http://phet.colorado.edu/en/simulation/photoelectric>

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2. Multimedia: Video & Audio

- Most effective in drawing students' attention.
- Duration: < 2 minutes / clip.

Movies:



Star Wars Episode III—Revenge of the Sith (2005)

(Unnecessary banking of
starfighters in outer space)

TV programs:



www.youtube.com/watch?v=2aMt-FoZw3I

Japanese-style tug-of-war

(Equal & opposite
action & reaction)

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2. Multimedia: Video & Audio

- Illustrate scientifically correct / incorrect concepts.

Cartoons:

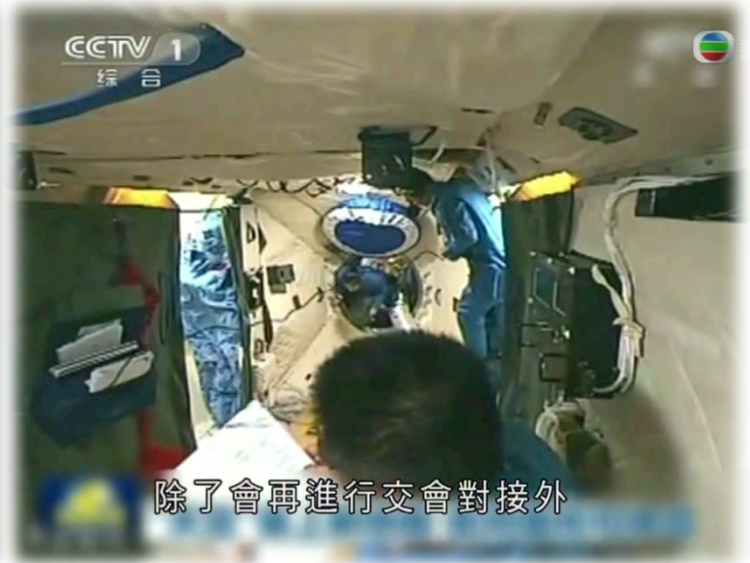


<http://www.youtube.com/watch?v=EURZLiOfM7k>

Mr. Bean

(Van de Graaff electrostatic generator)

News:



<http://www.youtube.com/watch?v=zzRqjIblRII>

TVB News at 6:30

[“Oxford’s” (牛津) Laws
vs. Newton’s (牛頓) Laws]

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2. Multimedia: Documentaries

- Present, in a leisurely way, historical background to broaden understanding.
- Arranged prior to relevant lectures.

The Fabric of the Cosmos—Quantum Leap (2011) / Brian Greene / NOVA

(Wave nature of particles):



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2. Multimedia: Apps

- Portable, fun and interactive.

Educational:

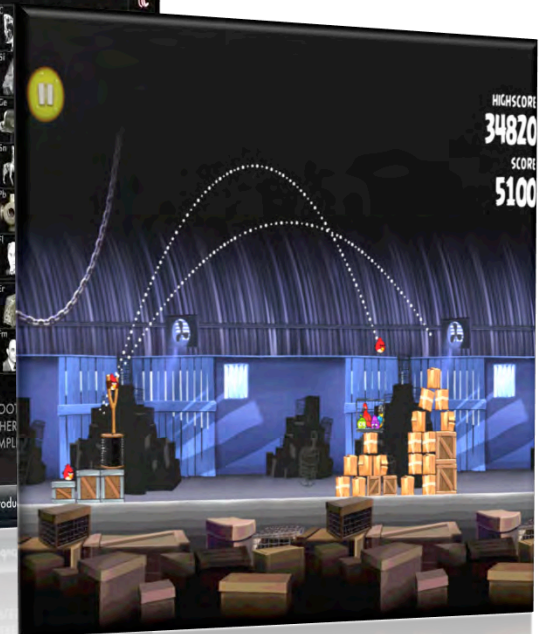


Solar Walk
(The solar system)



The Elements
(Atoms & molecules)

Games:



Angry Birds
(Projectiles)

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3. Demonstrations

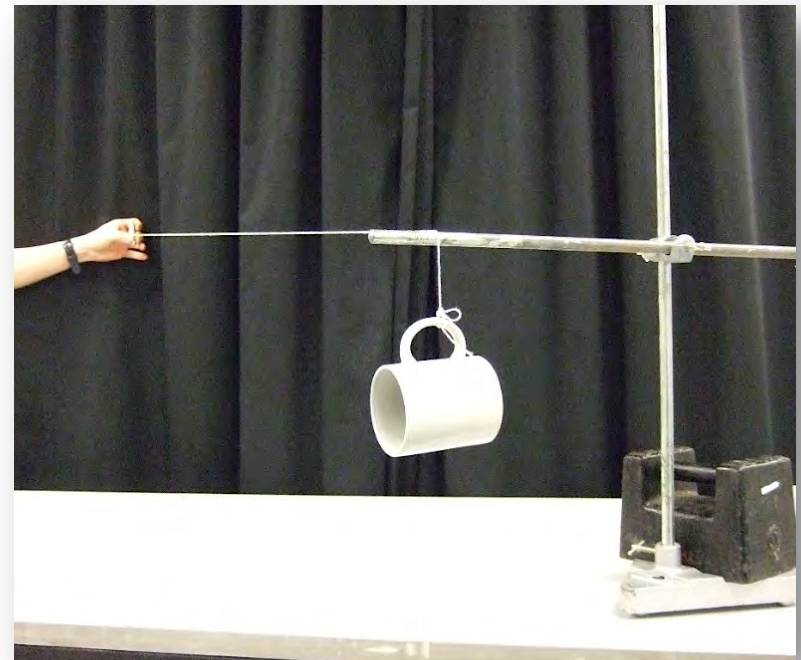
- Physics is empirical in nature.
- Simple tangible experiments help elucidate abstract theories.

Which one will hit the floor first: the heavier object (cup) or the lighter object (battery)?

Demonstrating:

- Conservation of Angular Momentum
- Conservation of Mechanical Energy

Swinging Atwood's machine:



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4. Nobel Prize & Shaw Prize

- Develop literacy in physical and technological innovations.
- Aware of impact of physics on society: economy, environment, ethics, *etc.*

The Nobel Prize in Physics 2009



Photo: U. Montan
Charles Kuen Kao
Prize share: 1/2



Photo: U. Montan
Willard S. Boyle
Prize share: 1/4



Photo: U. Montan
George E. Smith
Prize share: 1/4

The Nobel Prize in Physics 2009 was divided, one half awarded to Charles Kuen Kao "for groundbreaking achievements concerning the transmission of light in fibers for optical communication", the other half jointly to Willard S. Boyle and George E. Smith "for the invention of an imaging semiconductor circuit - the CCD sensor".

Photos: Copyright © The Nobel Foundation

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To cite this page

MLA style: "The Nobel Prize in Physics 2009". *Nobelprize.org*. Nobel Media AB 2014. Web. 1 Mar 2015. <http://www.nobelprize.org/nobel_prizes/physics/laureates/2009/>

FALL2014-15 PHYS1001 (L1)

Announcements

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Announcement

Subject The Shaw Prize in Astronomy 2014:

Saved By Yee Fai NG

Date Sep 9, 2014 10:51 pm

Groups site

Message

<http://www.shawprize.org/en/shaw.php?tmp=3&twoid=96&threeid=232&fourid=402>

Announcement

The Shaw Prize in Astronomy 2014

is awarded one-half to

Daniel Eisenstein

and the other half in equal shares to

Shaun Cole

and

John A Peacock

for their contributions to the measurements of features in the large-scale structure of galaxies used to constrain the cosmological model including baryon acoustic oscillations and redshift-space distortions.

<http://www.shawprize.org/en/shaw.php?tmp=3&twoid=96&threeid=232&fourid=402>

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5. Non-textbook References

■ The Web

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» Brain and Cognitive Sciences	» Mechanical Engineering
» Chemical Engineering	» Media Arts and Sciences
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» Comparative Media Studies	» <u>Physics</u>
» Comparative Media Studies/Writing	» Political Science
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» Economics	» Special Programs
» Edgerton Center	» Supplemental Resources
» Electrical Engineering and Computer Science	» Urban Studies and Planning
» Engineering Systems Division	» Women's and Gender Studies
» Experimental Study Group	» Writing and Humanistic Studies
» Global Studies and Languages	

<http://ocw.mit.edu/courses>

EngineerGuy.com The engineering details of all the stuff you wanna know about

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Make called Bill a "brilliant science-and-technology documentarian", whose "videos should be held up as models of how to present complex technical information visually" *Wired* called them "dazzling." *Scientific American's* blog called him a "smart, easygoing everyman with a firm understanding of the science." You can see 10 of his best videos below. He takes apart an LCD monitor, demonstrates how fiber optic cables work, rips up a hard drive, explains the wonder of a quartz wrist watch, solves the mystery of black boxes, blows up a light bulb filament, reveals how amazing a pop can tab truly is, shows why a cell phone looks like it does, and explains why you always seem to be in the slowest line.

Discover a Forgotten 19th Century Computer The Engineer Guy team's new book & video series celebrates a nineteenth century mechanical calculator that performed Fourier analysis by using gears, springs and levers to calculate with sines and cosines.

FREE PDF

Featured Video

LCD Monitor Bill tears apart a liquid crystal display to show how it works.

Hard drive teardown
Bill takes apart a computer hard drive to show how it's engineered to store data.

Fiber optic cables
Bill uses a bucket of propylene glycol to show how a fiber optic cable works and to show how engineers used them to send signals across oceans.

Quartz Watch
Bill takes apart a cheap watch to show how it works. He describes how a tiny quartz tuning fork keeps the time.

Black Box
In designing an object an engineer must choose the proper material. Never is this more important than in the "black box" flight data recorder.

Filament
Bill takes apart a light bulb to show how engineers make its filament.

Transistor
Bill shows how a transistor works by examining a replica of the first one ever built: The Bardeen-Brattain point contact transistor.

<http://www.engineerguy.com>

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5. Non-textbook References

■ Popular science bestsellers



Excerpts:

Why we need to know G as accurately as possible?

*... One reason is that this could pose a problem for **future space flights**, especially journeys to the stars...*

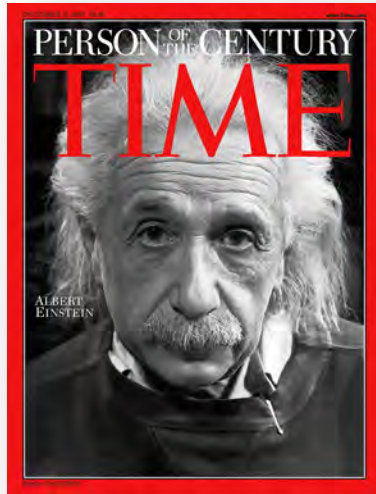
*... it would enable us to determine more accurately the **future positions of comets and asteroids** that might pose a threat to Earth...*

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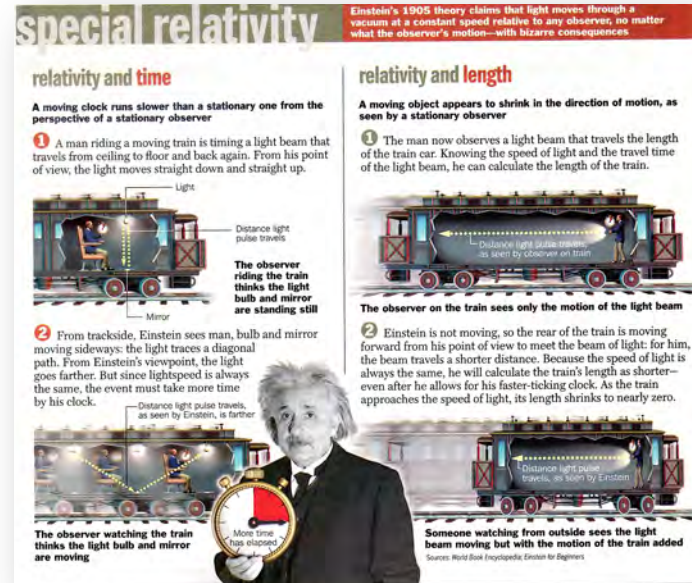
5. Non-textbook References

■ (Science) magazines

Paper:



Scans of relevant contents:



Digital:



Screenshots of relevant contents:

