

Rutgers Faraday Lecture: outline with past video clips and simulations (12/30/2013)

[An ongoing project: corrections/suggestions gratefully accepted.]

Rutgers Faraday Web Site <http://www.physics.rutgers.edu/~croft/FARADAY.HTML>New: Entire show videos of Rutgers Faraday 2013 Lectures on Rutgers YouTube at <https://www.youtube.com/playlist?list=PLqxsGMRIY6u5FO0FITvLHsrW0IDzDTD3>**Pictures from various Rutgers Faraday Lectures**<http://www.physics.rutgers.edu/~croft/Farad11pics.pdf><http://www.physics.rutgers.edu/~croft/Faraday2010gsh.pdf><http://www.physics.rutgers.edu/~croft/Farad09pics.pdf><http://www.physics.rutgers.edu/~croft/Farad08pics.pdf><http://www.physics.rutgers.edu/~croft/faraday-04-05-smaller.pdf><http://www.physics.rutgers.edu/~croft/FARADCHd.HTM><http://www.physics.rutgers.edu/~croft/d6-16-00.htm>**Recent Articles/Videos**American Physical Society Article <http://www.aps.org/publications/apsnews/201005/demo.cfm>Rutgers youtube video http://www.youtube.com/watch?v=A6De_ym_r7g**Targum Articles**2010: http://www.dailytargum.com/news/university/physics-experiments-bring-waves-of-children-to-annual-lecture/article_92ec674f-feef-5ba1-a619-64dde3993007.html?mode=story2013: http://www.dailytargum.com/news/professor-spices-up-class-experience/article_84fb6752-4c0d-11e3-99d8-0019bb30f31a.htmlCentral NJ: <http://www.mycentraljersey.com/article/20101208/NEWS/12080352/Annual-Rutgers-children-s-lecture-sure-to-wow-amaze>**Introduction** purpose of lecture <http://www.physics.rutgers.edu/~croft/purpose.wmv>: what the students like <http://www.physics.rutgers.edu/~croft/maim.wmv>**Galileo's $d=at^2/2$ Experiment** <http://www.physics.rutgers.edu/~croft/ballinc.avi><http://www.physics.rutgers.edu/~croft/inclplaneball.wmv>**Newton's 1st Law: Inertia:** objects at rest stay at rest and objects in motion stay in motion

- Table cloth and dishes at rest-stay at rest- (really more to it-friction) <http://www.physics.rutgers.edu/~croft/2007-dishes.wmv>
- Pencil Gun – object in motion tends to stay in motion (really more to it) <http://www.physics.rutgers.edu/~croft/2007pencile.wmv>
- 2 small hover craft (charge-use on table)

Newton's 2nd $F=ma$

- Hammer/hand/lead <http://www.physics.rutgers.edu/~croft/massresacc.wmv>

Newton's 3rd Force/reaction force :

- Balloon- gas-balloon <http://www.physics.rutgers.edu/~croft/2007baloon.wmv>
- Human Rocket -CO₂ fire extinguisher [Force reaction force: conservation of momentum]
<http://www.physics.rutgers.edu/~croft/2007fireext.wmv> <http://www.physics.rutgers.edu/~croft/Fireexting.wmv>

<http://www.physics.rutgers.edu/~croft/forcereact-fireex.wmv>See <http://www.physics.rutgers.edu/~croft/fetra.htm> for some video's and introductory physics explanations.See <http://www.physics.rutgers.edu/~croft/Fire-ext-Physics.pdf>introductory physics explanations. <http://www.physics.rutgers.edu/~croft/Fire-ext-Physics.pdf>Ira Flayto's Science Cabaret at Kenny's Castaways <http://www.physics.rutgers.edu/~croft/FEKennyscast.wmv>Ira Flayto's Science Cabaret at Brooklyn Aquarium <http://www.physics.rutgers.edu/~croft/FEaqua.wmv>

World Science Festival Street Fair 2008 <http://www.physics.rutgers.edu/~croft/WSF08-Rutgers.wmv>

Jerry Lewis elephant gun recoil clip <http://www.physics.rutgers.edu/~croft/lewisclip.wmv>

- Holding fire extinguisher off center creates rotation about center of mass
<http://www.physics.rutgers.edu/~croft/rot-fireext.wmv> <http://www.physics.rutgers.edu/~croft/fer.avi>
rotation with story about first fire extinguisher demo <http://www.physics.rutgers.edu/~croft/rotation-story.wmv>
- Hornblower movie, cannon recoil <http://www.physics.rutgers.edu/~croft/hornblower.wmv>

Things that rotate/turning forces:

• Bike Wheel

Axis of rotation - right hand rule for direction of rotation <http://www.physics.rutgers.edu/~croft/righthandrule.wmv>

Most screws are right handed screws <http://www.physics.rutgers.edu/~croft/rightscrew.wmv>

Most screws are right handed screws except for 1965 Dodge Dart

<http://www.physics.rutgers.edu/~croft/RightHandScrews.mpeg>

- Force through and perpendicular to axis (torque) – force + line of action

<http://www.physics.rutgers.edu/~croft/force-rot.wmv>

Rotation: distance of mass from axis very important

- Rotating chair axes – Axes & long Unistrut

<http://www.physics.rutgers.edu/~croft/axexs-rot.wmv>

<http://www.physics.rutgers.edu/~croft/2007axes.wmv>

Ira Flayto's Science Cabaret at Brooklyn Aquarium <http://www.physics.rutgers.edu/~croft/axeschairaqua08.wmv>

- ice skater rotation example <http://www.physics.rutgers.edu/~croft/2007skater.wmv>

Centripetal/Centrifugal Force -

- Ball on rope <http://www.physics.rutgers.edu/~croft/circmot.wmv>

- Waiter –tray –wine glass swung in circle <http://www.physics.rutgers.edu/~croft/waiterstray.wmv>

<http://www.physics.rutgers.edu/~croft/2007waiterstray.wmv>

At Ira Flayto's Science Cabaret at Brooklyn Aquarium

<http://www.physics.rutgers.edu/~croft/waittrayaqua08.wmv>

Energy- MOTION ENERGY – POSITION ENERGY-CHANGE IN ENRGY IMPORTANT

- Large Pendulum across the room CONSERVATION OF TOTAL ENERGY

<http://www.physics.rutgers.edu/~croft/2007pendulum.wmv>

The view from the ladder <http://www.physics.rutgers.edu/~croft/pendulumprofview.wmv>

Pendulum simulation http://phet.colorado.edu/sims/pendulum-lab/pendulum-lab_en.html

Potential Energy Kinetic Energy exchange REPEAT MOTION-VIBRATIONS

Natural time of ENERGY exchange - free vibrations

- Spring & weight (potential vs. kinetic energy) SIMULATION

http://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html

- Wine glass <http://www.physics.rutgers.edu/~croft/vibwhineglass.wmv>

- Singing rod/Rosin- nodes (zeros) exactly where expected <http://www.physics.rutgers.edu/~croft/SINGROD.MPG>

<http://www.physics.rutgers.edu/~croft/srod.htm> <http://www.physics.rutgers.edu/~croft/srod1.avi>

<http://www.physics.rutgers.edu/~croft/srod2.avi> <http://www.physics.rutgers.edu/~croft/srod3.avi>

Waves – traveling and standing

- Traveling transverse wave slinky - pulse - wiggle-(sine SH -wave)

http://phet.colorado.edu/simulations/sims.php?sim=Wave_on_a_String

Potential energy kinetic energy – traveling disturbance

Fourier Analysis <http://phet.colorado.edu/en/simulation/fourier>

Earth quake – compression wave arrives before damaging transverse waves

<http://www.physics.rutgers.edu/~croft/kobe.wmv>

- Smoke Ring maker/fogger propagating disturbance <http://www.physics.rutgers.edu/~croft/smokerings.wmv>

Standing waves SIMPLE HARMONIC WAVE

- Rope across Room

.. – Standing wave –SIMULATION <http://www.walter-fendt.de/ph14e/stwaveref1.htm>

Standing wave lecture slides <http://www.physics.rutgers.edu/~croft/standingwaves.pdf>

Special length- wave length related to length -- Special time – repeats in time

Big wave length-slow repeat time-low frequency Small wave length-short time repeat time-low frequency

- Flame tube standing wave. <http://www.physics.rutgers.edu/~croft/standingwave.mpg>

<http://www.physics.rutgers.edu/~croft/flametube.avi>

<http://www.physics.rutgers.edu/~croft/flametube1.wmv>

Light- vibrations of electric - magnetic field

Electromagnetic field SIMULATION <http://arana.cabrillo.edu/~jmccullough/Applets/Flash/Optics/EMWave.swf>

Radio waves simulation <http://phet.colorado.edu/en/simulation/radio-waves>

- Large block with laser pointer UV light Hair spray

Snell's Law of Refraction <http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=49>

<http://arana.cabrillo.edu/~jmccullough/Applets/Flash/Optics/ReflectionRefraction.swf>

<http://stwww.weizmann.ac.il/Lasers/laserweb/Java/Twoangles2.htm>

Light wave bending caused by wave speed slowing down

<http://arana.cabrillo.edu/~jmccullough/Applets/Flash/Optics/Refraction.swf>

- Disappearing beaker (or Test tube repair)

<http://www.kettering.edu/~drussell/Demos/reflect/reflect.html>

Light:Additional

-Spectrum with Prism (overhead projector) <http://www.physics.rutgers.edu/~croft/prism.jpg>

- Geometrical Optics <http://www.physics.rutgers.edu/~croft/divconvprism.jpg>

optics simulation http://phet.colorado.edu/sims/geometric-optics/geometric-optics_en.html

<http://www.mtholyoke.edu/~mpeterso/classes/phys301/geomopti/twolenses.html>

- Diffraction grating sheets

-Continuous Source (incandescent)- vary temperature - light color connection to temperature

-Simulation of Blackbody Spectrum-connection to temperature.

http://phet.colorado.edu/simulations/sims.php?sim=Blackbody_Spectrum

-“Black Body” and atomic light source (energy/light emission quantized) spectra

Essay <http://www.physics.rutgers.edu/~croft/spec.htm>

Lecture Material <http://www.physics.rutgers.edu/~croft/10-lec%20204-10-int-modphys-BBR-e-Ruth11-8-10.pdf>

-Simulation of quantum interaction of light with atom

http://phet.colorado.edu/simulations/sims.php?sim=Models_of_the_Hydrogen_Atom

- UV light & glow in the dark rocks/toys (high energy radiation)

fluorescent minerals

Fluorescent Rocks <http://www.physics.rutgers.edu/~croft/rocks.jpg>

<http://www.physics.rutgers.edu/~croft/rocks1col.jpg>

<http://www.physics.rutgers.edu/~croft/rocks2col.jpg>

<http://www.physics.rutgers.edu/~croft/rocks3col.jpg>

Fluorescence spectra [11-Fl-spectra-good-12-1-10.pdf](http://www.physics.rutgers.edu/~croft/11-Fl-spectra-good-12-1-10.pdf)

Fluorescence & Laser notes <http://www.physics.rutgers.edu/~croft/11-Fluorescence-Laser.pdf>

Video of exponential time decay of mineral Phosphorescence <http://www.physics.rutgers.edu/~croft/flroc1.avi>

-IR light focus to light matches

Resonance –push object at "special times <http://www.walter-fendt.de/ph14e/resonance.htm>

- Chinese Bowl on Camera
- Break Glass with Sound <http://www.physics.rutgers.edu/~croft/breakingbeaker.wmv>
<http://www.physics.rutgers.edu/~croft/glasssh.avi>

Tacoma Narrows Bridge collapse: wind driven resonance and bridge collapse.

<http://www.physics.rutgers.edu/~croft/ColorTacoma%20Narrows.wmv>

or <http://www.youtube.com/watch?v=POFi1VcbpAI>

Fluids - Gases - Pressure - Density - Temperature:**Density - mass/volume Fluids:**

- Diet vs. Sugar coke add salt - sugar coke now less dense than more dense salt water container ready
<http://www.physics.rutgers.edu/~croft/coke-sugdiet.wmv>
adding salt makes the water more dense <http://www.physics.rutgers.edu/~croft/addsault.wmv>
- Bowling Balls in water <http://www.physics.rutgers.edu/~croft/bowlingball.mpg>
- Buoyancy-density ducks vs. cormorant <http://www.physics.rutgers.edu/~croft/bouancy-ducks.png>
- Buoyancy - Hydrogen & He Balloons less dense than air
-explode H_2 balloon $2H_2 + O_2 \rightarrow H_2O + \text{energy}$
With explanation <http://www.physics.rutgers.edu/~croft/baloons.wmv>
just explosion <http://www.physics.rutgers.edu/~croft/H2balloon.avi>
- Beans & lead vs ping pong balls <http://www.physics.rutgers.edu/~croft/beans.htm>

Density simulation <http://phet.colorado.edu/en/simulation/density>

TEMPERATURE PRESSURE SIMULATIONS

- For simple gas temperature = average energy of motion
http://phet.colorado.edu/simulations/sims.php?sim=Gas_Properties
<http://www.falstad.com/gas/>
states of matter simulation <http://phet.colorado.edu/en/simulation/states-of-matter>

Pressure:

- Vacuum pump-crush large drum start and let run (someone time) <http://www.physics.rutgers.edu/~croft/cancrsh.htm>
- Crush Coke Can <http://www.physics.rutgers.edu/~croft/cokeatmcancrush.mpg>
lecture slide <http://www.physics.rutgers.edu/~croft/pcan.htm>
- Vacuum pump (or cooling) -crush large drum <http://www.physics.rutgers.edu/~croft/drumcast08.wmv>
<http://www.physics.rutgers.edu/~croft/drumlowbw.mpg>
Bed of nails Pressure = force / area. Remember for later
- Train Tanker crushed by atmospheric pressure <http://www.physics.rutgers.edu/~croft/improperly-vented-sealed-tank.wmv>

Fluid motion: Bernoulli effect.

- Bernoulli ball (leaf blower)- <http://www.physics.rutgers.edu/~croft/bernouliball.jpg>
<http://www.physics.rutgers.edu/~croft/Bernoulli.wmv>
air plane wing <http://www.physics.rutgers.edu/~croft/airplanewing.jpg>
- Tunnel into NY : doors in train station –<http://www.physics.rutgers.edu/~croft/Bernoulli-train.htm>
- Toilet paper – pulled/pushed int low pressure high speed air
<http://www.physics.rutgers.edu/~croft/bern-toiletP.wmv> <http://www.physics.rutgers.edu/~croft/toilp.JPG>

<http://www.physics.rutgers.edu/~croft/toilp1.JPG>

- Bernoulli tubes <http://www.physics.rutgers.edu/~croft/bernotubes.avi>

Temperature:

-Liquid Nitrogen - -Freeze: **flower**, banana Hot dog broccoli baloney

- Shrink helium balloon - density connection <http://www.physics.rutgers.edu/~croft/Hebaloon.mpg>
with explanation <http://www.physics.rutgers.edu/~croft/HebalooninN2.wmv>
- Liquid Nitrogen cannon –<http://www.physics.rutgers.edu/~croft/N2cannon.wmv>
- Other constrained explosions <http://www.physics.rutgers.edu/~croft/planetneb.png>
-Freeze: **flower banana Hot dog broccoli baloney**

Electricity and Magnetism:

- Balloon and charge- web CHARGES OPP ATTRACT LIKE REPEL
http://phet.colorado.edu/simulations/sims.php?sim=Balloons_and_Static_Electricity

Electric charges and forces:

- Flowing current - Glowing Pickle heat – light
Pickle light video in 2 parts <http://www.physics.rutgers.edu/~croft/pickle.wmv>
<http://www.physics.rutgers.edu/~croft/picklecont.wmv>
- Capacitor discharge: STORES ENERGY SLOWLY – DISCHARGE FAST
<http://www.physics.rutgers.edu/~croft/capicitordis.JPG>

Magnetism - magnetic force on moving charges:

- Oscilloscope –and magnet
- Jumping wire in magnet <http://www.physics.rutgers.edu/~croft/MAGWIRE.avi>
<http://www.physics.rutgers.edu/~croft/MAGWIRESIDE.avi>
- Faraday's motor <http://www.physics.rutgers.edu/~croft/fma.avi>
<http://www.physics.rutgers.edu/~croft/fmal.avi> <http://www.physics.rutgers.edu/~croft/fmas.avi>

Changing magnetic field - makes charges move in circle:

- Coils/meters/magnet: Faraday's Law drop http://phet.colorado.edu/simulations/sims.php?sim=Faradays_Law
<http://phet.colorado.edu/en/simulation/faraday> <http://phet.colorado.edu/en/simulation/generator>

Eddy Currents:

- Inclined plane/magnet and disks: solid disk in magnet-slotted disk in magnet (zigzag cut disk in magnet)
[motional energy converted to electrical current flow]
Video <http://www.physics.rutgers.edu/~croft/eddyincl.wmv>
Lecture slides <http://www.physics.rutgers.edu/~croft/induced-current-slides.pdf>
More schematics of this demo <http://www.physics.rutgers.edu/~croft/eddycur.htm>
solid, slotted, zig-zag cut disk in magnet <http://www.physics.rutgers.edu/~croft/3disks.wmv>
- Magnet falling through tube <http://www.physics.rutgers.edu/~croft/magnetintube.wmv>
Induced current simulation <http://web.mit.edu/jbelcher/www/java/falling/falling.html>
- Inclined plane and Nd-magnet [2007magnetonplane.wmv](http://www.physics.rutgers.edu/~croft/2007magnetonplane.wmv)

Moving charge creates magnetic field:

Combinations of induced current and force on moving charge:

- Ring flinger <http://www.physics.rutgers.edu/~croft/ringflinger.wmv>
<http://www.physics.rutgers.edu/~croft/coillightringfling.avi>

Ring flinger schematics <http://www.physics.rutgers.edu/~croft/ring-flinger-slides.pdf>
or <http://www.physics.rutgers.edu/~croft/ringind.htm>

Grand Finale:

- Bed of Nails/Brick & Sledge <http://www.physics.rutgers.edu/~croft/bednailscast08.wmv>
<http://www.physics.rutgers.edu/~croft/nailcinder.htm>

Additional Material

On Bohr, U and Th <http://www.physics.rutgers.edu/~croft/U238-U235crosssection.png>

On the WWII Pu-implosion bomb <http://www.physics.rutgers.edu/~croft/Puimplosion.png>

On Aristotle, Newton and a 500 Pound Gorilla (Friction). <http://www.physics.rutgers.edu/~croft/aristotle.htm>

On the Bernoulli effect and the New Brunswick to New York train ride.

<http://www.physics.rutgers.edu/~croft/Bernoulli-train.htm>

Galileo Galilei's Anagram. <http://www.physics.rutgers.edu/~croft/ANAGRAM.htm>

Jacob's ladder <http://www.physics.rutgers.edu/~croft/jlall.JPG>

soap bubble shapes <http://www.physics.rutgers.edu/~croft/soapcol.jpg>

A case study in the mathematics of friction <http://www.physics.rutgers.edu/~croft/friction-case-study.pdf>