Physics 133 Demos and Demo Schedule

Physics for Scientist and Engineers, A strategic Approach **4th Edition**

More information can be found here: https://physics.calpoly.edu/physics-133-demos-and-demo-schedule

All YouTube videos are tagged with:
The Demo Guy, CP SLO, Cal Poly Physics, Physics, PHYS 123/133, [Demo Name]

Week 1

CH 22: Electric Charges and Forces

Electrostatic Charge

1) **Triboelectric Series Visual:** A list of materials showing which charge they favor when contacted with other materials
2) **Electrophorus**: Rub the base with fur, and then place the metal plate on top and ground it. After grounding the plate, the base and plate become oppositely charged which can be shown with a charge sensor or electroscope.
3) **Electroscopes:** When a charged object is brought near it, the arms deflect. Use to show induced charge separation and the polarity of charges, or to help verify an unknown charge.

The Coulomb Force

1) **Coulomb Pivots**: Charge different rods by any method, and then use the charged rod to attract or repel a second rod placed on a pivot stand.
2) **Pith Balls:** Small hanging sphere(s) which are conductive. Transfer charge through contact, and use the sphere(s) to show attractive and repulsive interactions.
3) **Electrostatic Pom-Pom**: Charge these through contact with a charged rod or Van de Graaff generator (VDG). When charged, they will spread out trying to maximize distance between like charges, and can be used to verify charges if one object has a known charge.
4) **Transferring Charge:** Place a small thin line of saw dust on the desk, and charge a plastic rod with fur. Then, bring the rod close to the line of sawdust to initially attract it through induction. The dust will then quickly begin to jump off the rod as charge is transferred to the saw dust making it have the same charge as the rod.
5) **Acceleration from Induction:** Charge a rod, and bring it close to an aluminum can. The can will begin to roll towards the rod because of the induced charge seperation.
6) **Bending Water**: Allow a light stream of water to fall from a faucet. When a charged rod is brought near the stream, it will bend towards the rod.
7) **Electrostatic 2x4**: After setting the 2x4 on its pivot, a charged object can be used to cause the 2x4 to rotate.
8) **Coulomb and Distance:** Using a static charge generator, 2 metal plates, and an electroscope, show your students that as you increase the distance between the two plates the strength of the induced charge decreases following an inverse square law1
9) **Van de Graaff Generator:** A belt and roller carry charge up to the conductive spherical dome.
    - Static Discharge Arcs
    - Student Hair and Pom-Poms (works best on light thin hair…red/blonde, swimmers)
    - Flying Pie Tins and Paper
    - Rotating Flux Capacitor

Weeks 2/3

CH 23+24: The Electric Field and Gauss's Law

Electric Fields

1) **Torque on a Dipole**: A football shaped conductor is held in an electric field created between two charged plates. Charges will separate towards the ends of the conductor, and a torque results causing the football to rotate.
2) **Radio Silence:** Turn the hand-held radio onto an AM station showing that it works. Then, place the radio in the Faraday cage showing that it will shield EM waves.
3) **Van de Graaff Generator:** A belt and roller carry charge up to the conductive spherical dome.
    - Static Discharge Arcs
    - Student Hair and Pom-Poms (works best on light thin hair…red/blonde, swimmers)
    - Flying Pie Tins and Paper
    - Rotating Flux Capacitor
4) **Wimshurst Machine**: Make sure to rotate the crank clockwise, and engage or disengage the capacitors based on desired outcome.
    - Static Discharge Arcs and distance
    - Energy Storage in Capacitors
    - Singing Paper and Creating Ozone
    - Visualizing Electric Fields with Pom Poms

Capacitors and Electric Fields

1) **Capacitor Basics:** Charge up two parallel plates and connect them to either a capacitance meter or an electroscope. Adjust the distance between the plates to observe a change in the capacitance.
2) **Electrostatic Doorbell:** A conductive sphere is placed in the E-field between two plates charged by the static charge generator. Initially nothing happens, but once you touch the sphere to one of the charged plates it will begin to ricochet back and for the between the plates as it transfers and changes its charge.

Weeks 4/5

CH 25+26: The Electric Potential and Potential and Field

Capacitors and Capacitance

1) **Capacitor Examples:**
   - Electrolytic: aluminum and tantalum.
   - Nonelectrolytic: mylar, mica, and ceramic.
   - Variable Capacitors
   - Cut Open Capacitor
   - List of Capacitor Values
2) **Capacitor Basics:** Charge up two parallel plates and connect them to either a capacitance meter or an electroscope. Adjust the distance between the plates to observe a change in the capacitance.
3) **Dielectrics:** With the same setup from above, add or remove dielectric sheets in between the closely spaced plates to observe a change in capacitance.

Capacitors Store Energy

1) **Wimshurst Machine**: Make sure to rotate the crank clockwise, and engage or disengage the capacitors based on desired outcome.
   - Static Discharge Arcs and distance
   - Energy Storage in Capacitors
   - Singing Paper and Creating Ozone
   - Visualizing Electric Fields with Pom Poms
2) **Hand Crank Generators:** Generators, energy storage, and motors can all be shown by using the generator with various other devices.
   - Small Light Bulb (generator)
   - Capacitor (energy storage)
   - 2nd Hand Crank (generator and motor)
3) **Capacitor Charging and Discharging:** As a large capacitor charges its electric potential is displayed on an analog voltmeter, and the current can be visualized by the brightness of a bulb in series. You can discharge the capacitor through the bulb, or use a screw driver to rapidly discharge it.

***** This last method can be dangerous, you MUST watch my video before attempting this*****

Batteries

Assortment of Batteries:
   - Dry Cells
   - Wet Cells
   - Cut Open Batteries
   - Citrus Battery ***bring your own citrus**

Week 6/7

CH 27+28: Current and Resistance and Fundamentals of Circuits

Conduction

1) **Conduction in Solutions:** **DANGER** The exposed leads can cause a dangerous and potentially lethal shock when plugged in, so always place them in a beaker BEFORE plugging them in. Fill the beaker with enough water so that at least 1 cm of the leads are immersed. Slowly add salt until the bulb begins to illuminate, and then swirl beaker.
2) **Conductors vs Insulators:** Use a handheld high frequency generator to quickly investigate what types of materials are conductive.

Resistance and Resistors

1) **The Mean Free Path and Resistance:** Marbles are rolled down an incline plane with pegs (or a rain-stick) showing the electron mean free path through a conductor. You can then vary the angle of the plane to demonstrate the effect of EMF on current.
2) **Circuit Elements:** Examples of resistors, potentiometers, circuit boards and other common components that could be found in common circuits.
3) **Resistance and Temperature:** Batteries, a switch, an exposed filament, and a light bulb are all set up in series. Close the switch, heat the exposed filament with a lighter, and as it warms up the bulb dims. Conversely, you can blow on the filament to brighten the bulb.
4) **Wire Resistances:** Show students different wires and measure their resistances with an ohmmeter. **When measuring resistances include power resistor in series so as to not blow the fuse on the ohmmeters.**
5) **Joule heating:** Current is sent through an ni-chrome wire causing the wire to become red hot. You can then slide a piece of paper through the wire as it burns through it like a hot knife through butter. ****WARNING **** You will short out the power supply so please include a resistor block in series.
6) **Parallel & Series Circuits**: Bulbs are wired in such a way that they can be flipped back and forth between parallel or series. Use this as an example, or an introduction to get students to start a discussion on how they work and their properties.

****WARNING**** Any demos that require a power supply can be “shorted out” easily.
Please be aware of your circuits, and include a contact key switch
or resistor block when necessary.

Weeks 8/9

CH 29: The Magnetic Field

Magnets and the Magnetic Field

1) **Magnet Assortment:**
    - Bar Magnets (Broken and Whole)
    - Horse Shoe Magnets
    - Cow Magnets
    - Magnetite
    - “Is it magnetic?”
2) **Seeing Magnetic Field Lines:** Various compasses, iron filings, or ferromagnetic rods can be arrayed around magnets to help create a visualization of the magnetic field lines.
3) **Dip Needle:** Use to show the inclination of the Earth's B-field (around 60 degrees from horizontal in S.L.O.).

The Magnetic Force

1) **The Magnetic Force**: Using bar magnets or needles on pivots, a magnetic Newton’s Cradle, or some donut magnets along a cylinder, show students the influence of the magnetic force.
2) **The Oersted Effect:** Place small compasses around any of our wire configurations embedded in acrylic, and when current is applied, the compasses will deflect. You can also use the large current ring with a compass needle in the center to show a similar effect

** WARNING: Always include a contact key switch in series with your wire configurations, and**
** do not hold down for extended periods of time to avoid damaging the PSU.**

3) **Electron Deflection:** Illuminate electron tube with the handheld Tesla coil (high frequency generator), and deflect beam with neodymium magnet. **X-Ray Source, limit exposure**
4) **Wire Deflection:** A current is sent through a conductor next to a horseshoe magnet. Do not hold switch down for extended periods of time.
5) **Vibrating Lights:** Hold strong magnet (look on the light bulb base) next to hot filament. Vibrations result due to the interaction between the alternating current and magnetic field.
6) **Forces on Current Carrying Wires:** Apparatus is plugged in and set up so that current can run down the rotating conductive bars in either the same or opposing directions.

** Pressing the button creates a short circuit. Do not hold for longer than a second. **

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or resistor block when necessary.

Week 10, Chapter 30

CH 30:Electromagnetic Induction

Inductance

1) **Assortment of Inductors**: A collection of common household items that use inductors.
2) **Back E.M.F.:** A 6-volt battery is connected to a coil with a neon bulb in parallel to the coil. When the switch is engaged, D.C. is allowed to flow. When the switch is then opened the back EMF causes the Neon bulb to flash which requires around 90V!
3) **Induced Currents:** A galvanometer is connected to a coiled wire. When a cow magnet is inserted and removed from the coil, an induced current is displayed on the galvanometer.
4) **Color Changing LED:** An LED (actually a red and green LED housed in the same covering) is connected to a wire coil. Move the coil rapidly into (or, out of) the B-field. L.E.D. lights up red or green depending on the induced current's direction.
5) **Creating Current with Coils:** A small primary coil is connected to a battery, while a larger secondary coil is connected to a galvanometer. Either move the primary coil in and out of the secondary coil, or switch the current on and off to show that a changing electric field in a conductor can induce a current in nearby conductors.

Eddy Currents

1) **Eddy Current Pendula:** Two aluminum sheets, one with a solid plate the other with a comb-like plate, are set on a ring stand and allowed to rotate freely like a pendulum. When both are released into a strong magnetic field the solid sheet will stop due to eddy currents.
2) **Eddy Current Tubes:** First, drop a non magnetic object such as a marble or small stone through a copper tube. Then, drop a powerful magnet through the same tube. Due to the eddy currents it creates it feels a repulsive force against gravity and accelerates at a lesser rate.
3) **Feeling Eddy Currents**: Using a sheet of copper and a strong magnet, allow students to slide the magnet along the sheet. Or, place a strong magnet and similar sized object on the same sheet. When inclined, the magnet will slide noticeably slower.
4) **Fling the Ring:** Use the Elihu Thompson apparatus (with and without the iron core) to induce a current in various ring-like objects. Depending on whether or not the ring has a gap in it, the Eddy current will shoot the ring upwards.

Generators and Motors

1) **Simple Motor**: Consists of a battery, a magnet, and a rigid coil of wire suspended above the magnet. Once set up, give the coil a small push and it will continue to rotate. ***WARNING: You will short out the batter if the coil is left on the supports long, so please remove it! ***
2) **Hand Crank Generators:** Generators, energy storage, and motors can all be shown by using the generator with various other devices.
    - Small Light Bulb (generator)
    - Capacitor (energy storage)
    - 2nd Hand Crank (generator and motor)
3) **DC and AC Generators**: A small wire coil is rotated in a magnetic field. Depending on where leads are connected you can generate AC or DC current as seen on a galvanometer.
4) **Electromagnetic Motor**: Using a 12V DC power supply, plug in banana leads to the available ports. Then, slowly increase the voltage and you can get the motor spinning quite rapidly!

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or resistor block when necessary.