List of Demonstrations

Newton's First Law
- Car on Level Track
  A car maintains constant motion on a level air track.
- Car on Inclined Track
  Air track simulation of Galileo's rolling ball experiment.
- Ball Dropped
  A ball is dropped while walking or running.

Newton's Second Law
- Cars Being Pulled (F = ma)
  Cars on a level air track are pulled with several different forces.
- Cars Released and Collide
  Two cars of different masses are allowed to "explode" apart, or allowed to collide.

Newton's Third Law
- Colliding Cars and "Rocket" Balloon
  Cars of various masses and bumpers are allowed to collide on a level air track, and a "rocket" car and a "rocket" balloon are demonstrated.
- Roller Board
  A person standing on a roller board pushes against the wall or pushes or pulls against another person.
- Car on Road
  A car accelerates on a surface which is capable of moving.

Free Fall and Projectile Motion
- Feather and Coin
  A feather and a small weight are dropped in a glass tube, with and without air resistance.
- Drop Ball and Throw Ball
  A ball is dropped while another ball at the same time is thrown horizontally.
- Drop Objects
  Different objects are released by the demonstrator as he stands on the top of the classroom table.
- Throw Ball Upward
  A ball is thrown straight up and then allowed to fall straight down to the original level.
- Monkey Shoot
  A hanging toy monkey is dropped and then hit by a small steel ball.
- Projectile Motion
  A ball is thrown through the air as a projectile.

Gravity, Circular Motion, and Satellites
- Circular Motion
  Different objects are set into circular motion.
- Gravity and Weight
  A weight hanging from a hanging scale is accelerated upward and then downward.
- Satellite Motion
  Objects are set into motions similar to orbiting satellites.
- Ball in Orbit
  A ball is thrown horizontally several times at successively higher speeds.

Linear Momentum
- Collision of Cars
  Cars of different masses and bumpers collide on an air track.
- Car and Pendulum
  A car with an attached pendulum glides on an air track.

Collision of Balls
  Six pendulum balls on a "swinging-balls" apparatus collide elastically.
- Car and Balloon
  A car with an attached "rocket" balloon is propelled along a level air track.

Work and Energy
- Objects Pulled and Lifted
  Work is demonstrated by pulling and lifting various objects.
- Bowling Ball
  A bowling ball suspended as a pendulum is set to swing.
- Falling Balls
  Balls are dropped and the respective rebound distances are measured.
- Lift Weights
  Heavy weights are lifted using simple machines.
- Loop-the-loop
  A ball is allowed to move on a loop-the-loop track.
- WF Pendulum
  A weight attached to a Wilberforce pendulum oscillates in different modes.
- Swinging Toy Lion
  A toy lion suspended as a pendulum is raised and lowered.

Torque, Center of Mass, and Rotational Inertia
- Torque and Equilibrium
  A torque is applied to various objects.
- Center of Mass and Equilibrium
  Objects of various sizes and shapes are tested for their location of center of mass and equilibrium condition.
- Rotational Inertia: Weights
  Rotational inertia is demonstrated using a barbell with weights at various distances from the center.
- Rotational Inertia: Hoop and Disk
  A hoop and a disk and various solid cylinders and spheres are rolled down an inclined plane.

Angular Momentum
- Rotating Weights
  A demonstrator holds weights and rotates on a platform.
- Bicycle Wheel
  A demonstrator holds a bicycle wheel and rotates on a platform.
- Spinning Phonograph Disk
  A disk with string at its center spins while it swings.
- Cat-Twist
  A mechanical model of a cat is used to demonstrate how an inverted cat dropped with zero angular momentum can still land on its feet.

Pressure and Density
- Pressure Definition (P = F/A)
  The pressure of a heavy block of lead is measured.
- Pressure in Liquids
  The pressure of water is demonstrated at various depths.
- Atmospheric Pressure Experiments - Part 1
  Various experiments are performed to demonstrate atmospheric pressure.
- Atmospheric Pressure Experiments - Part 2
  Some additional effects of atmospheric pressure are demonstrated.
- Density
  The density of some solids and liquids is measured and demonstrated.
- Buoyancy: Archimedes' Principle
  Archimedes' Principle and the buoyant force are demonstrated.
• **Buoyancy: Styrofoam Block**
The buoyant force is demonstrated and measured by floating a large Styrofoam block in water.
• **Buoyancy: Floating Bubbles**
The buoyant force is demonstrated by floating soap bubbles on a fog of carbon dioxide.
• **Buoyancy: Density Effects**
The cartesian diver and the Galileo thermometer are demonstrated.
• **Bernoulli Tube**
A Bernoulli tube is used to demonstrate the pressure change in a moving fluid.
• **Bernoulli's Principle: Air Foil and Pieces of Paper**
By blowing air over and between various surfaces, Bernoulli's principle is demonstrated.
• **Bernoulli's Principle: Ping-Pong Ball**
A ping-ball is suspended in a stream of moving air to demonstrate the lower pressure within the stream.
• **Bernoulli's Principle: Drawing Liquid**
By blowing air over the top of a glass tube, water is pushed up the tube, demonstrating the lower pressure within the moving air.
• **Bernoulli's Principle: Hose Attached to a Faucet**
Bernoulli's effect is demonstrated in fast moving water inside a transparent hose.

**Waves and Sound Waves**
• **Waves on a Rope**
Waves and resonance are demonstrated using a long rope attached to the wall.
• **Waves on a Slinky**
A slinky is used to demonstrate longitudinal and transverse waves.
• **Waves on a Beam**
A 2-m long stick and tuning forks are used to demonstrate standing waves on a beam.
• **Resonance and Vibrating Strings**
Sound produced by different vibrating strings is demonstrated.
• **Resonance and Tuning Forks**
Sound produced by different tuning forks is demonstrated.
• **Resonance and Sound Pipes**
Sound wave resonance produced in open pipes and closed pipes is demonstrated.
• **Resonance and Rod**
By stroking an aluminum rod, sound waves are produced.
• **Resonance and Saw Blade**
Standing waves which produce sound are demonstrated by stroking a circular saw blade with a violin bow.
• **Sound Waves: Frequency and Amplitude**
Using a tuning fork and an oscilloscope, the frequency and amplitude of sound waves are demonstrated.
• **Sound Waves: Quality**
Using an oscilloscope, the quality of sound is demonstrated.
• **Sound Waves: Beats**
The phenomenon of beats is demonstrated with the aid of a signal generator and an oscilloscope.
• **Sound Waves: Whirly Tubes and Alp Horn**
Whirly tubes and an alp horn are used to demonstrate resonance and sound waves.

**Thermal Physics**
• **Temperature and Internal Energy**
Temperature is demonstrated by simulating molecular motion. Internal energy is demonstrated by heating water and by grinding a nail.
• **Thermal Expansion**
Thermal expansion is demonstrated by heating various solids.
• **Change of Phase**
Change of phase is demonstrated for melting ice, boiling water, and evaporation of water.
• **Radiation**
Heat transfer by radiation is demonstrated by reflection of infrared rays to a radiometer.
• **Convection**
Heat transfer by convection currents is demonstrated by heating air inside a vertical, hollow metal tube.
• **Conduction**
Heat transfer by conduction is demonstrated for various materials.
• **Gas Law**
The ideal gas law is demonstrated by varying the pressure, volume, temperature, and number of molecules of a gas (container of air).
• **Expansion Cooling**
Expansion cooling is demonstrated by allowing compressed air to suddenly expand.

**Electrostatics**
• **Forces Between Charged Objects**
The electric force between two charged ping-pong balls is demonstrated.
• **Charged Electrode**
An electrode is charged and demonstrated.
• **Electric Forces on Neutral Objects**
Neutral objects are shown to be attracted to charged objects.
• **Inducing Electric Charge on an Electrode**
With a charged rubber rod nearby, the uncharged electrode is touched by hand, allowing negative charges to leave.
• **Inducing Electric Charge Using Two Metal Spheres**
A charge is induced on a metal sphere as it touches another metal sphere in the electric field of a Van de Graaff generator.
• **Surface Charge**
A metal sphere is charged and is shown that all charges reside on its surface.
• **Charging a Person**
A person is electrically charged while touching the dome of a Van de Graaff generator.
• **Electric Field: General**
The electric field of a Van de Graaff generator is demonstrated.
• **Electric Field: Examples**
A Van de Graaff generator is charged and shown to apply electric forces to charged objects. The electric field is shown to be stronger near sharp points.
• **Electric Field Breakdown**
Two charged metal spheres are brought close to each other to demonstrate the electric discharge through the air.
• **Electric Field Shielding**
A Van de Graaff generator, a wire cage, and an oscilloscope are used to demonstrate electric field shielding.

**Electric Circuits**
• **Ohm's Law: Basic**
The relationship between current and resistance is demonstrated for a fixed voltage.
• **Ohm's Law and Power**
The relationship between current and voltage is demonstrated for a fixed resistance. Electric power is also demonstrated.
• **Resistors in Series**
A circuit with two resistors in series is demonstrated.
• **Resistors in Parallel**
A circuit with two resistors in parallel is demonstrated.
Capacitance
- Capacitance: Wimshurst Machine
  A Wimshurst machine is used to demonstrate the concept of capacitance and charge storage.
- Parallel Plate Capacitor
  The dependence of the capacitance on different variables is demonstrated.
- Charge and Discharge
  A capacitor is charged and then slowly discharged through a light bulb.

Magnetism
- Permanent Magnets
  The magnetic forces and the iron fillings patterns of magnetic fields are demonstrated for permanent magnets.
- Oersted's Experiment
  Oersted's original discovery is demonstrated.
- Field Lines of a Coil
  The magnetic filed lines of a current-carrying coil are demonstrated.
- Field Lines of a Wire
  The magnetic field lines of different wire geometries are demonstrated.
- Magnetic Forces on a Beam of Electrons
  A magnet is brought near a beam of electrons in a cathode ray tube and the magnetic force is demonstrated.
- Force Between Two Wires
  The magnetic force between two current-carrying wires is demonstrated.
- Jumping Wire Experiment
  The magnetic force on a current-carrying wire in a magnetic field is demonstrated.
- Ferromagnetic Pole Reversal
  A strong magnet is used to change the polarity of a small bar magnet.
- Induced Ferromagnetism
  An iron rod is shown to become magnetized when placed in the core of a current-carrying coil.
- Electric Motor
  The magnetic forces on the coils in a simple electric motor are demonstrated.

Faraday's Law of Induction
- Faraday's Discovery
  Faraday's original discovery is demonstrated by observing the induced current in the secondary of overlapping coils.
- Magnet in Coil
  Faraday's law is demonstrated by moving a magnet in and out of a coil.
- Hand Generator
  A small hand cranked generator is used to produce a current in a light bulb.
- Transformer
  A small light bulb is lit by placing it in the changing magnetic field of an AC coil.
- Jumping Ring
  A conducting ring is observed to be propelled upward by the changing magnetic field of a coil.
- Eddy Current Brake
  Magnetic forces are observed on conducting and nonconducting plates as they move between the poles of a magnet.
- Dropping Magnet
  A magnet is observed to move slowly while falling through a copper tube.

Inductance
- General Demonstration
  An inductor is used to create a large emf across a switch and arcing is observed.
  - Dependence on Permeability (\(\mu\))
    Different materials are placed in the core of an inductor and the inductance is measured.
  - Dependence on Number of Turns (\(N\))
    The inductance of a coil is measured as the number of turns is doubled while other variables remain constant.
  - Dependence on Length (\(l\))
    The inductance of a coil is measured as the length is changed while other variables remain constant.
  - Dependence on Cross Sectional Area (\(A\))
    The inductance of two coils of different cross sectional areas is measured and compared.

Reflection of Light
- Law of Reflection
  A laser beam, illuminated by chalk dust, is reflected from a plane mirror.
- Blackboard Optics
  Blackboard optics is used to demonstrate reflection from different surfaces and to show focal points.
- Object-Image Diagrams
  Object-image diagrams are shown for various mirrors.
- Plane Mirror
  The image formation for a plane mirror is demonstrated.
- Multiple Mirrors
  The image formation for a two-mirror system is demonstrated.
- Convex Mirror
  The image formation for a convex mirror is demonstrated.
- Concave Mirror - Object at Large Distance
  The image formation for a concave mirror with the object at a relatively large distance is demonstrated.
- Concave Mirror - Object at Short Distance
  The image formation for a concave mirror with the object at a relatively short distance is demonstrated.
- Concave Mirror - Magnifier
  The image formation for a concave mirror with the object at a distance less than the focal length is demonstrated.

Refraction of Light
- Law of Refraction
  Blackboard optics is used to demonstrate refraction as light passes through a block of plastic.
- Total Internal Reflection
  Total internal reflection is demonstrated for different refracting media.
- Dispersion
  White light is passed through a prism to produce the spectrum of colors and demonstrate dispersion.
- Apparent Depth
  A plastic block is used to demonstrate apparent depth by using blackboard optics and also by using the overhead projector.
- Focal Lengths of Lenses
  Blackboard optics is used to demonstrate the focal lengths of various lenses.
- Diverging Lens
  Image formation for a diverging lens is demonstrated.
- Converging Lens - Object-Image Diagrams
  Using chalkboard diagrams, image formations are described for a converging lens.
- Converging Lens - Object at Large Distance
  Image formation for a converging lens with the object at a relatively large distance is demonstrated.
- Converging Lens - Object at Short Distance
  Image formation for a converging lens with the object at a relatively short distance is demonstrated.
Telescope
Two converging lenses are used to demonstrate a telescope.

Lens Defects
- Spherical and Chromatic Aberrations
  Blackboard optics is used to demonstrate chromatic aberration and spherical aberration.
- Farsightedness
  A converging lens is used to demonstrate the correction for farsightedness.
- Nearsightedness
  A diverging lens is used to demonstrate the correction for nearsightedness.
- Astigmatism
  A lens of nonuniform curvature is used to demonstrate astigmatism.

Interference and Diffraction
- Double-Slit Interference
  Two overlapping transparencies on the overhead projector are used to simulate the interference from two coherent sources.
- Interference Simulation Using Polarized Light
  A rotating polarizing transparency on the overhead projector is used to simulate the double-slit interference pattern.
- Thin Film Interference: Oil Surfaces
  Oil is dropped onto a water surface and the interference pattern is observed.
- Thin Film Interference: Soap Bubbles
  The thin film interference of soap bubbles is demonstrated.
- Interference: Hologram
  A hologram is demonstrated.
- Single-Slit Diffraction: Laser
  A single-slit together with a laser is used to demonstrate a diffraction pattern.
- Single-Slit Diffraction: Line Filament
  A single-slit together with a line filament light source is used to demonstrate a diffraction pattern.
- Diffraction: Various Objects
  Various objects together with a laser are used to form diffraction patterns.

Polarization of Light
- Polarized Light: General Demonstration
  Polarizing sheets are employed to demonstrate polarized light.
- Polarized Light: Stacked Polarizing Sheets
  Three polarizing sheets are used to demonstrate the rotation of the polarization plane.
- Polarized Light: Optical Activity
  Optically active materials are used to demonstrate the rotation of the polarization plane.
- Polarized Light: LCD
  Light from a liquid crystal display on a hand-held calculator is demonstrated to be polarized.
- Polarized Light: Laser
  Light from a He-Ne laser is demonstrated to be polarized.
- Polarized Light: Sky Light
  Light scattered from the sky is demonstrated to be partially polarized.
- Polarized Light: Car Glare
  A polarizing sheet is used to diminish the glare from cars in a parking lot.
- Interference Simulation Using Polarized Light
  A rotating polarizing sheet on the overhead projector is used to simulate the double-slit interference pattern.

Electromagnetic Waves
- Electromagnetic Spectrum
  The entire EM spectrum is discussed and radio waves emitted by a transmitter are detected by a receiving antenna.
- Visible Spectrum
  A prism is used to demonstrate the visible spectrum.
- Primary Colors
  A transparency on the overhead projector is used to demonstrate the additive and subtractive primary colors.
- Shielding of EM Waves
  The shielding of radio waves is demonstrated by covering a radio with a wire cage.

Modern Physics
- Emission of Light
  Various electric discharge tubes are used to demonstrate the spectrum of emitted light from excited gas atoms.
- Fluorescence and Phosphorescence
  An ultraviolet light source is used to illuminate various fluorescent materials and a visible light source is used to energize a phosphorescent ball.
- Photoelectric Effect
  Electrons are demonstrated to be ejected from a metal plate when the plate is illuminated by ultraviolet light, but not ejected when illuminated by visible light.
- Radioactivity
  A Geiger counter in conjunction with various absorbers is used to demonstrate radiation from radioactive sources.
- Cloud Chamber
  The tracks of radioactive particles as they pass through a cloud chamber are shown.
- Michelson-Morley Experiment
  A Michelson interferometer is used to demonstrate the original experiment of Michelson and Morley.
- Time Dilation
  Time dilation is illustrated using two identical "light clocks" in relative motion.