7: Modern Physics

7A: Quantum Effects
7B: Atomic Physics
7D: Nuclear Physics
7E: Elementary Particles
7F: Relativity

7A: Quantum Effects

7A10. Photoelectric Effect

Photoelectric Effect with Electroscope (7A10.10) -- bright white light from an arc lamp strikes a metal plate mounted atop a negatively charged electroscope. The electroscope discharges quickly if the plate is zinc, less quickly for aluminum or copper. Will not discharge if a plate of glass is held between the light and the zinc (cuts out UV), or if the electroscope is positively charged.

Photomultiplier Tube -- show and tell.

7A15. Millikan Oil Drop

Millikan Oil Drop (7A15.10) -- recreation of the classic experiment used to find the charge of the electron.

Millikan Oil Drop Analog -- Two parallel metal plates are connected to a Wimshurst machine with a pith ball connected to the bottom plate. As the machine is cranked, the electric field increases and eventually the force on the pith ball will overcome the force of gravity and it will levitate between the plates. Note: This uses the same setup as the Bouncing Ping-Pong Balls (5B10.30) but without the ping-pong balls.

7A20. Compton Effect

7A50. Wave Mechanics

Microwave Barrier Penetration (7A50.20) -- microwaves are beamed into a large plastic prism, and are totally internally reflected off to the side (the detector shows no microwaves penetrating straight through). When another prism is slid up against the first to make a square, the microwaves suddenly penetrate straight through both prisms even though there is still a tiny air gap between the two.

Vibrating Circular Wire (7A50.40) -- A 10" diameter loop of thin wire is attached to a speaker driver and driven at specific frequencies that set up standing waves in the loop. Useful for talking about de Broglie waves.

See also Standing Waves in Rubber Tubing (Varying Frequency) (3B22.10).
7A55. Particle/Wave Duality

7A60. X-ray and Electron Diffraction

**Electron Diffraction (7A60.10)** -- electrons emitted from a hot filament are diffracted through a thin layer of polycrystalline graphitised carbon (which acts like a diffraction grating) and hit a fluorescent screen. The diffraction pattern consists of a central bright spot of undeflected electrons and two concentric rings. The diameters of the rings can be changed by altering the accelerating voltage of the electrons (increasing the momentum decreases the de Broglie wavelength).

**Bragg Diffraction of Microwaves (7A60.50)** -- microwaves are beamed into a model "atomic lattice" consisting of regularly-spaced metallic cylinders. Interference fringes are observed as the detector is rotated around the lattice.

**Sample X-ray Tubes (7A60.95)** -- various commercial tubes.

7A70. Condensed Matter

See section 1R50. Crystal Structure.

7B: Atomic Physics

7B10. Spectra

**Bohr Atom (Hydrogen Spectrum)** -- the spectrum from a Hydrogen spectra tube is seen by the class using pass-out transmission gratings. This is similar to the following demo (Line Spectra) but with only Hydrogen and no other gases.

**Line Spectra (7B10.10)** -- Hydrogen, Neon, Mercury, and Helium emission tubes are examined with transmission gratings which are handed out to the students. The sources are arranged in a vertical stack and operate simultaneously, so that all four spectra are seen at once. A white light atop the stack may be turned on separately to compare a continuous spectrum with the four quantized emission spectra.

7B11. Absorption

**Absorption by Sodium Vapor (7B11.25)** -- a salt-soaked stainless steel screen is held in a flame in front of two backlit screens; one lit by white light and the other by sodium light. In front of the white light screen, the flame is transparent and faintly yellow. In front of the yellow sodium light screen, the flame appears black.

**Absorption Spectrum of Neophan Glass** -- a piece of neophan glass inserted into a continuous spectrum demonstrates broad absorption lines in the yellow and green areas of the spectrum (used to cut out sodium emission glare from hot glass).

7B13. Resonance Radiation

**Triboluminescence (7B13.05)** -- Crush wintergreen lifesavers and they give off faint flashes of light.

**Ultraviolet in the Spectrum (7B13.40)** -- light from a Carbon arc lamp is spread into a continuous spectrum, and a fluorescent sheet placed beyond the violet end of the spectrum fluoresces where no visible light exists. Note: This is done on the same setup as Infrared in the Spectrum (6B40.41).

**Fluorescence (7B13.50)** -- various fluorescent materials are available for viewing under ultraviolet light, including natural minerals, man-made objects, liquids, and paints.
Luminescence (7B13.55) -- a luminescent rubber ball, skeleton etc. which may be charged up by normal (or UV) light for a glow-in-the-dark effect.

Chemiluminescence -- one of those chemical light sticks. Break the vial inside and as the two chemicals mix they emit a green glow.

7B20. Fine Splitting
7B30. Ionization Potential

Frank-Hertz Experiment (7B30.20) -- classic experiment demonstrating quantized energy levels of bound electrons. A voltage/current curve for a discharge through Mercury vapor is displayed on the oscilloscope and seen to contain repetitive peaks and valleys.

7B35. Electron Properties

Discharge Tube and Vacuum Pump (7B35.10) -- electric current runs through a long glass tube as it is being evacuated. The glow from the current goes from nothing at atmospheric pressure to a maximum at low pressure and finally back to nothing when the tube is fully evacuated. At the proper pressure level, a structured discharge is seen.

Note: The simple Crooke's Tube is in Section 5: Electricity and Magnetism.

Crooke's Tube with Maltese Cross (7B35.40) -- electrons fly through a discharge tube and cause a phosphor screen at the end of the tube to glow. Raise a metal cross into the path of the electrons and a cross-shaped shadow appears on the screen, showing that electrons travel in straight lines.

Crooke's Tube with Paddle Wheel (7B35.50) -- a small paddlewheel is free to roll along the axis of a Crooke's Tube. When current is flowing through the tube, electrons strike the paddles and transfer momentum to the wheel, rolling it along the tube. Reverse the current and the wheel rolls the other way.

Plasma Tube (7B35.75) -- an evacuated tube containing a metal conductor is energized by a Tesla coil and forms long flickering streamers of current which are attracted to fingers touching the outside of the tube.

7B50. Atomic Models

7D: Nuclear Physics
7D10. Radioactivity

Geiger Counter (7D10.10) -- commercial Geiger counter detects beta and gamma rays. Both artificial and natural radioactive sources are available. Probe and source can be put in a special frame which allows the distance between them to be varied to determine the effect on count rates. Absorbers of different materials fit in slots in the frame to demonstrate their effect on intensity.

Half-Life (7D10.20) -- a computer-based Geiger counter is used to demonstrate the half-life of a short-lived isotope. A chemical extraction process is used to isolate an isotope of protactinium with a half-life of about 100 seconds (the isotope is a daughter product of a much longer-lived isotope). The Geiger counter measures the count rate of the beta decay for the protactinium and displays it in graph form as count rate vs. time. The rapid decay of the isotope can easily be seen and a rough calculation of the half-life can be done. Note: The software is currently non-functional. We're working on it.
7D20. Nuclear Reactions
7D30. Particle Detectors

**Cloud Chamber (7D30.50)** -- an automatically cycling Wilson cloud chamber shows the tracks of alpha particles from a Radium source.

7D40. NMR

**Nuclear Magnetic Resonance** -- nuclei of atoms in an intense magnetic field absorb radio-frequency energy at their resonant frequency; shows as a "blip" on the voltage in a small pickup coil. Note: We need at least one day's notice.

7D50. Models of the Nucleus

**Rutherford Scattering Model (7D50.10)** -- an analogue of Rutherford's classic alpha scattering experiment has rolling ball bearings which strike a "nucleus" and scatter at various angles.

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7E: Elementary Particles
7E10. Miscellaneous

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7F: Relativity
7F10. Special Relativity

**Streib's Relativity Machine (7F10.10)** -- a device which simulates length and time contraction at relativistic speeds.

**Length Contraction Board (7F10.32)** -- show and tell item with boards of different lengths to display the Lorentz contraction at 0, .9c, .99c, .999c, etc.

7F20. General Relativity

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