Virginia Tech Department of Physics

Physics Instructors Handbook

Edited and Maintained by Clark Snelgrove

Physics Classroom Demonstrations

Short Table of contents

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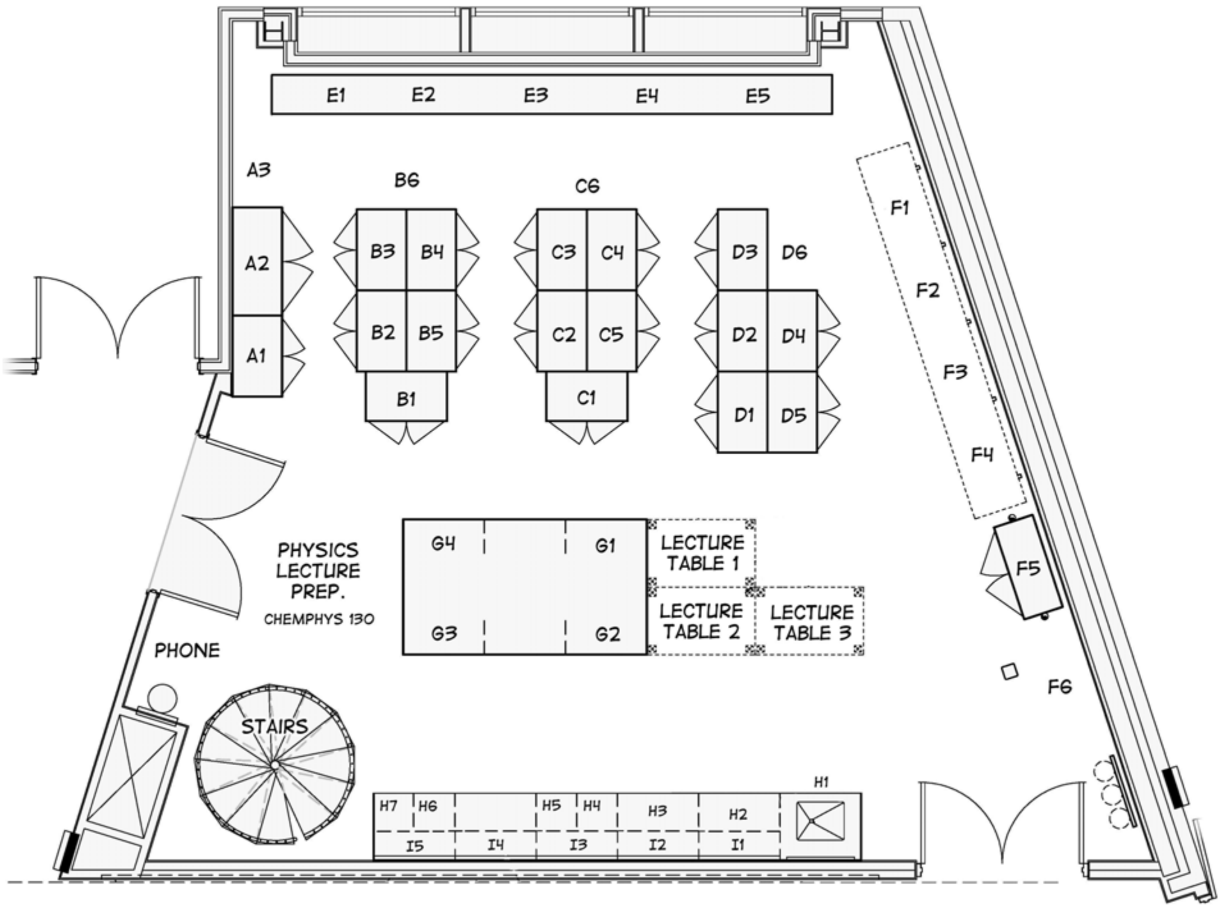
7. Using Audio/Visual equipment in Robeson Hall

CHEMP 130 Lecture Demonstration Map



Click on the storage loacation to see a list of items stored in that loaction. Click here for additional instructions on how to use this map.

Virginia Tech Physics

Lecture demo list

Educational Resources

Policies and Procedures for Using Lecture Demonstration and Audio/Visual Services

1. Using Demonstrations in CHEMP 130.
2. Using Audio/Visual equipment in CHEMP 130.
3. Using the Audience Response System in CHEMP 130.
4. Using Demonstrations in Robeson Hall.
5. Using Audio/Visual equipment Robeson Hall.

Suggested Demonstrations by Physics course

1. Physics 2205 (Physics 6th ed., Cutnell & Johnson)
2. Physics 2206 (Physics 6th ed., Cutnell & Johnson)
3. Physics 2305 (University Physics 11th ed., Young & Freeman)
4. Physics 2306 (University Physics 11th ed., Young & Freeman)

Demonstration room (CHEMP 130A) storage location map

Curriculum Planning Tools and Ideas

1. Demonstration web pages at other schools
2. Introductory Laboratory Home Page
3. Physics Instructional Resource Association (PIRA)
4. Why Use a Physics Demonstration? (by Clark Snelgrove)

Physics Education Research based teaching tools

1. Just in Time Teaching (JiTT)
2. Audience Responce System (Peer Instruction type materials and others)
3. Interactive Lecture Demonstrations

Physics Education Books (Clark Snelgrove has copies of all of these that can be borrowed)

1. Peer Instruction, Eric Mazur
2. Five Easy Lessons, Randall D. Knight
3. Teaching Physics with the Physics Suite, Edward F. Redish
4. Physlet Physics, Wolfgang Christan, Mario Belloni
5. Ranking Task Exercises in Physics, Thomas L. O'Kuma, et al
6. Teaching Introductory Physics, Arnold B. Arons
7. Just in Time Teaching

Physics Education Research Groups (University of Maryland list)

Virginia Tech Physics Lecture demo list

Using Physics Demonstrations In CHEMP 130

Lecture Demonstration signup procedure:

1. Instructors are free to get out their own demonstrations from the storage areas in CHEMP 130A. (See the demonstration area map for what is stored in each location). There is no deadline for requesting demonstrations that instructors are willing to get out for themselves but we ask that they still sign up on the demonstration website (http://www.phys.vt.edu/demo-bin/demoform.cgi) so that a log of demonstration usage can be kept. If instructors choose to get out their own demonstrations they should place them on a cart in CHEMP 130A when they finished being used. One of the demonstration staff will reshelf the demonstations.

2. For instructors who would like to have their demonstration prepared by the demonstration stafff please sign up for demonstrations by **NOON** on the day before they need to use them. Sign up is done at: http://www.phys.vt.edu/demo-bin/demoform.cgi. The demonstration staff will set up the demonstrations on carts in CHEMP 130A (the demonstration room behind the lecture hall CHEMP 130). For demonstrations that have been requested before noon on the day before, the demonstration will be set up by 4 PM. The equipment will be checked to verify that it is functioning properly. Thus, the demonstrations will be ready all that evening and the next day for practice by the instructor if they would like to do that. The instructors will responsible for rolling out their own demonstration carts and returning them to 130A. The demonstration staff will reshelve the demonstrations after they are used. If instructors find that they need additional support in this area please contact Mark Pitt or Clark Snelgrove.

3. Training on the use of demonstrations and other educational resources in CHEMP 130 is available from the demonstration staff. Please contact Clark Snelgrove. (crsnel@vt.edu, 231-5272) to schdule a time.

4. Clark Snelgrove is also very receptive to ideas for improving existing demos or creating new ones, and he is available to try to implement your ideas.

Virginia Tech Physics Lecture demo list

Using Audio/Visual Equipment in CHEMP 130

To AudioVisuals Page

The following Audio/Visual equipment and other lecture resources are available in Chemistry/Physics 130:

1. Lutron lighting controller
2. Crestron A/V controller
3. Two Epson video projectors mounted on the ceiling (Contact Classroom A/V, 231-3874, for problems with this equipment)
4. Two wireless microphones
5. Dual monitor Windows based computer with network connections, wireless mouse/keyboard, and USB hub
6. Cannon Visulizer document camera
7. Pasco ScienceWorkshop 750 Interface for taking experimental data
8. Video switch for choosing various video inputs including laptop computers
9. Two close-up cameras for displaying small demonstrations
10. DVD/VHS player
11. LaserDisk player
12. Samsung Video/Computer Preview Monitor (CHEMP 130A)
13. Red Laser pointer (stored in cabinet I1)
14. Whiteboards and markers

Audio/Visual Materials signup procedure:

1. There is no need to sign up to use the A/V equipment in CHEMP 130. Most of the equipment is permanently store where it can easily be used.
2. Instructors are free to get out their own A/V materials from the storage areas in CHEMP 130A. (See the demonstration area map for what is stored in each location). There is no deadline for requesting A/V materials that instructors are willing to get out for themselves but we ask that they still sign up on the Audio/Visual web site (http://www.phys.vt.edu/demo-bin/avform.cgi) so that a log of demonstration usage can be kept. If instructors choose to get out their own A/V materials they should be place them on the counter next to the sink in CHEMP 130A when they are finished being used. One of the demonstration staff will reshelf the A/V materials.
3. For instructors who would like to have their A/V materials prepared by the demonstration staff please sign up for demonstrations by **NOON** on the day before they need to use them. Sign up is done at: http://www.phys.vt.edu/demo-bin/avform.cgi. The demonstration staff will set up the A/V materials on carts in CHEMP 130A (the demonstration room behind the lecture hall CHEMP 130). For A/V materials that have been requested before noon on the day before, the A/V materials will be set up by 4 PM. The A/V materials and equipment will be checked to verify that it is functioning properly. Thus, the A/V materials will be ready all that evening and the next day for practice by the instructor if they would like to do that. Instructors should return the cart with A/V materials to CHEMP 130A when they are finished using them. The demonstration staff will reshelve the A/V materials after they are used. If instructors find that they need additional support in this area please contact Mark Pitt or Clark Snelgrove.
4. Training on the use of A/V materials and other educational resources in CHEMP 130 is available from the demonstration staff. Please contact Clark Snelgrove. (crsnel@vt.edu, 231-5272) to schedule a time.

Audience Response System

Virginia Tech Physics Lecture demo list

Using Physics Demonstrations in Robeson Hall

Lecture Demonstration signup procedure:

1. Instructors are free to get out their own demonstrations from the storage areas in CHEMP 130A and ROB 206A for use in Robeson Hall. (See the demonstration area map for what is stored in each location). There is no deadline for requesting demonstrations that you are willing to get out for yourself but we ask that you still sign up on the demonstration website (http://www.phys.vt.edu/demo-bin/demoform.cgi) so that a log of demonstration usage can be kept. If you choose to get out your own demonstrations please place them on a cart when you are finished and returen them to CHEMP 130A or ROB 206A. One of the demonstration staff will reshelf them.

2. For instructors who would like to have their demonstration prepared by the demonstration stafff please sign up for demonstrations by **NOON** on the day before they need to use them. Sign up is done at: http://www.phys.vt.edu/demo-bin/demoform.cgi. The demonstration staff will set up the demonstrations on carts in ROB 206A (the demonstration room beside the lecture hall ROB 210). For demonstrations that have been requested before noon on the day before, the demonstration will be set up by 4 PM. The equipment will be checked to verify that it is functioning properly. Thus, the demonstrations will be ready all that evening and the next day for practice by the instructor if they would like to do that. The instructor will need to pick up their demonstrations from ROB 206A before their class and return them when they are finished. The demonstration staff will reshelved the demonstrations after they are used. If instructors find that they need additional support in this area please contact Mark Pitt or Clark Snelgrove.

3. Training on the use of demonstrations and other educational resources in CHEMP 130 is available from the demonstration staff. Please contact Clark Snelgrove. (crsnel@vt.edu, 231-5272) to schdule a time.

4. Clark Snelgrove is also very receptive to ideas for improving existing demos or creating new ones, and he is available to try to implement your ideas.

Virginia Tech Physics Lecture demo list

Using Audio/Visual Equipment in Robeson Hall

To AudioVisuals Page

Audio/Visual Equipment and Materials signup procedure:

1. Instructors using rooms in Robeson Hall have many A/V options. Many of the rooms have equipment in them that is maintained by The University's Classroom Audio/Visual services (231-3874). Please contact them if you have any problems with their equipment. Physcis department staff are not able to support Classroom A/V's equipment.
2. Instructors who need additional A/V support can use the physics departments A/V equipment stored in ROB 206A. (See To AudioVisuals Page for information on what is available and to sign up for equipment use). Instructors are expected to sign out the equipment in ROB 206A using sign up page. This equipment should be picked up from and returned to ROB 206A after use. Limited support on the use of this equipment is available from physics department staff.
3. Instructors are free to get out their own A/V materials from the storage areas in CHEMP 130A. (See the demonstration area map for what is stored in each location). There is no deadline for requesting A/V materials that instructors are willing to get out for themselves but we ask that they still sign up on the Audio/Visual website (http://www.phys.vt.edu/demo-bin/avform.cgi) so that a log of A/V usage can be kept. If instructors choose to get out their own A/V materials they should place them on the counter next to the sink in CHEMP 130A when they finished being used. One of the demonstration staff will reshelf the A/V materials.
4. For instructors who would like to have their A/V equipment and materials prepared by the demonstration stafff please sign up for A/V materials by **NOON** on the day before they need to use them. Sign up is done at: http://www.phys.vt.edu/demo-bin/avform.cgi. The demonstration staff will set up the A/V materials on carts in ROB 206A (the room beside the lecture hall in ROB 210). For A/V materials that have been requested before noon on the day before, the A/V materials will be set up by 4 PM. The equipment will be checked to verify that it is functioning properly. Thus, the A/V materials will be ready all that evening and the next day for practice by the instructor if they would like to do that. The demonstration staff will reshelve the A/V materials after they are used
5. Training on the use of A/V materials and other educational resources in CHEMP 130 is available from the demonstration staff. Please contact Clark Snelgrove. (crsnel@vt.edu, 231-5272) to schedule a time.
6. Clark Snelgrove is also very receptive to ideas for improving existing A/V materials, or creating new ones, and he is available to try to implement your ideas.

Virginia Tech Physics   Lecture demo list

Virginia Tech Department of Physics

Physics AudioVisual Resources

Virginia Tech physics instructors may sign up for demonstrations by checking the appropriate boxes below and then filling out the submission form below.

To Demonstrations Page

Audio-Visual Equipment

(To Submission Form)

- ☐ CMPC: Rollabout PC
- ☐ CMMC: Rollabout Macintosh
- ☐ LPRJ2: LCD projector 2
- ☐ LPRJ1: LCD projector 1
- ☐ MPRJ: Movie Projector
- ☐ SPRJ: Slide Projector
- ☐ TVVT: Large TV monitor with videotape player
- ☐ TVCD: Large TV monitor with CD player
- ☐ TV00: Large TV monitor only

Videodisks

(To Submission Form)

The Mechanical Universe

Each topic is 30 minutes long. Chapter 50 is an index.

- ☐ MU01: Intro to the Mechanical Universe
- ☐ MU02: The Law of Falling Bodies
- ☐ MU03: Derivatives
- ☐ MU04: Inertia
- ☐ MU05: Vectors
- ☐ MU06: Newton's Laws
- ☐ MU07: Integration
- ☐ MU08: The Apple and the Moon
- ☐ MU09: Moving in Circles
- ☐ MU10: The Fundamental Forces
- ☐ MU11: Gravity, Electricity, Magnetism
- ☐ MU12: The Millikan Experiment
- ☐ MU13: Conservation of Energy
- ☐ MU14: Potential Energy
- ☐ MU15: Conservation of Momentum
- ☐ MU16: Harmonic Motion
- ☐ MU17: Resonance
- ☐ MU18: Waves
- ☐ MU19: Angular Momentum
- ☐ MU27: Beyond the Mechanical Universe
- ☐ MU28: Static Electricity
- ☐ MU29: The Electric Field
- ☐ MU30: Potential and Capacitance
- ☐ MU31: Voltage, Energy and Force
- ☐ MU32: Electric Battery
- ☐ MU33: Electric Circuits
- ☐ MU34: Magnets
- ☐ MU35: The Magnetic Field
- ☐ MU36: Vector Fields and Hydrodynamics
- ☐ MU37: Electromagnetic Induction
- ☐ MU38: Alternating Current
- ☐ MU39: Maxwell's Equations
- ☐ MU40: Optics
- ☐ MU41: The Michelson-Morley Experiment
- ☐ MU42: The Lorentz Transformation
- ☐ MU43: Velocity and Time
- ☐ MU44: Mass, Momentum, Energy

- ☐ MU20: Torques and Gyroscopes
- ☐ MU21: Kepler's Three Laws
- ☐ MU22: The Kepler Problem
- ☐ MU23: Energy and Eccentricity
- ☐ MU24: Navigating in Space
- ☐ MU25: From Kepler to Einstein
- ☐ MU26: Harmony of the Spheres
- ☐ MU45: Temperature and Gas Law
- ☐ MU46: Engine of Nature
- ☐ MU47: Entropy
- ☐ MU48: Low Temperatures
- ☐ MU49: The Atom
- ☐ MU50: Particles and Waves
- ☐ MU51: Atoms to Quarks
- ☐ MU52: The Quantum Mechanical Universe

Physics: Cinema Classics

- ☐ CC01: Mechanics I
- ☐ CC02: Mechanics II and Heat
- ☐ CC03: Waves I
- ☐ CC04: Waves II and E&M
- ☐ CC05: Conservation Laws
- ☐ CC06: Angular Momentum and Modern Physics

Other Videodisks

- ☐ AS01: Astronomy (Images and movies)
- ☐ PI01: Photons / Interference of Photons (30 minutes)
- ☐ PL01: Planetscopes (Images and movies)
- ☐ PS01: Physics Science I (30 minutes)
- ☐ PS02: Physics Science II (30 minutes)
- ☐ PTEN: Powers of 10 (8 minutes, Eames Side 1, Ch. 3)
- ☐ SU01: The Sun (Images and movies)
- ☐ TN01: The Puzzle of the Tacoma Narrows Bridge Collapse (30 minutes)
- ☐ VG01: Voyager Gallery (Images and movies)

Videotapes (To Submission Form)

The Mechanical Universe

Each topic is 30 minutes long. Chapter 50 is an index.

- ☐ MT01: Intro to the Mechanical Universe
- ☐ MT02: The Law of Falling Bodies
- ☐ MT03: Derivatives
- ☐ MT04: Inertia
- ☐ MT05: Vectors
- ☐ MT06: Newton's Laws
- ☐ MT07: Integration
- ☐ MT08: The Apple and the Moon
- ☐ MT09: Moving in Circles
- ☐ MT10: The Fundamental Forces
- ☐ MT11: Gravity, Electricity, Magnetism
- ☐ MT12: The Millikan Experiment
- ☐ MT13: Conservation of Energy
- ☐ MT14: Potential Energy
- ☐ MT15: Conservation of Momentum
- ☐ MT16: Harmonic Motion
- ☐ MT27: Beyond the Mechanical Universe
- ☐ MT28: Static Electricity
- ☐ MT29: The Electric Field
- ☐ MT30: Potential and Capacitance
- ☐ MT31: Voltage, Energy and Force
- ☐ MT32: Electric Battery
- ☐ MT33: Electric Circuits
- ☐ MT34: Magnets
- ☐ MT35: The Magnetic Field
- ☐ MT36: Vector Fields and Hydrodynamics
- ☐ MT37: Electromagnetic Induction
- ☐ MT38: Alternating Current
- ☐ MT39: Maxwell's Equations
- ☐ MT40: Optics
- ☐ MT41: The Michelson-Morley Experiment

- ☐ MT17: Resonance
- ☐ MT18: Waves
- ☐ MT19: Angular Momentum
- ☐ MT20: Torques and Gyroscopes
- ☐ MT21: Kepler's Three Laws
- ☐ MT22: The Kepler Problem
- ☐ MT23: Energy and Eccentricity
- ☐ MT24: Navigating in Space
- ☐ MT25: From Kepler to Einstein
- ☐ MT26: Harmony of the Spheres
- ☐ MT42: The Lorentz Transformation
- ☐ MT43: Velocity and Time
- ☐ MT44: Mass, Momentum, Energy
- ☐ MT45: Temperature and Gas Law
- ☐ MT46: Engine of Nature
- ☐ MT47: Entropy
- ☐ MT48: Low Temperatures
- ☐ MT49: The Atom
- ☐ MT50: Particles and Waves
- ☐ MT51: Atoms to Quarks
- ☐ MT52: The Quantum Mechanical Universe

Other Videotapes

- ☐ CLT1: Coulomb's Law (from PSSC series)
- ☐ FRT1: Frames of Reference (from PSSC series)
- ☐ IUT1: The Invisible Universe & Making of the 140' Telescope 13+ (30 minutes)
- ☐ NVT2: What Einstein Never Knew (NOVA 1989; 1 hour)
- ☐ NVT1: Feynman (NOVA 1989; 1 hour)
- ☐ P10T: Powers of 10 (8 minutes)
- ☐ PLT1: Mars & Mercury, Explore Two Planets (60 minutes)
- ☐ PPT4: Physics for Phun (AAPT; 30 minutes)
- ☐ PWT1: The Changing Physical World
- ☐ QKT3: Quarks (NOVA 1989; 1 hour)
- ☐ SLT2: Video of Twelve Skylab Films (AAPT; 30 minutes)
- ☐ SOT1: Demonstrations in Acoustics (Richard Berg; 29 sections, 3-12 minutes each)
- ☐ SWT1: Smithsonian World Series: The Quantum Universe (WETA; 1 hour)
- ☐ TNT3: Tacoma Narrows Bridge Collapse (AAPT; 10 minutes)
- ☐ TST1: Toys in Space (AAPT; 1 hour)
- ☐ VMT1: Jupiter, Saturn & Uranus, The Voyager Missions (60 minutes)
- ☐ VMT2: Voyager: Neptune Encounter Highlights (30 minutes)

Your name:

[ ]

Room:

CHEMP 130 ▾

Date and time when demonstration is needed:

8:00am ▾ Mar ▾ 3 ▾ 2006 ▾

Additional instructions or comments:

Mechanics

- M01: Pasco dynamics Track
- M04: Equilibrium of Forces
- M05: Methods for Measuring Motion
- M09: Hover Puck
- M10: Newton's First Law-Table Cloth Trick
- M11: Inertia Ball
- M12: Newton's Third Law-Opposing scales
- M20: Egg and Sheet
- M24: Air Track Demonstrations
- M28: Falling Bodies
- M32: Feather and Coin
- M34: Air Drag
- M36: Monkey and Hunter
- M38: Ballistic Car
- M42: Dynamics of Circular Motion
- M45: Air Table Collisions
- M50: Nose Basher

Mechanics

M55: Carbon Dioxide Rocket cart

M56: Low Friction Game of Catch

M58: Balls for Bouncing Collisions

M59: Collisions of Balls

M60: Frictional Properties of Materials

M61: Inclined Plane Problems

M64: Center of Gravity

M65: Center of Gravity Toys

M70: Central Force Demo

M72: Loop the Loop

M73: Rotational Inertia

M74: Angular Acceleration-Rolling Bodies

M76: Conservation of Angular Momentum

M78: Rotational Platform

M79: Torsion Pendulum

M80: Simple Harmonic Motion (SHM)

M81: SHM Using the Air Track

M82: Action/Reaction in SHM

M83: Reference Circle in SHM

M84: The Physical Pendulum

M85: Forced Vibrations

M86: Coupled Oscillators

M87: Wilberforce Pendulum

M90: Symmetrical Top

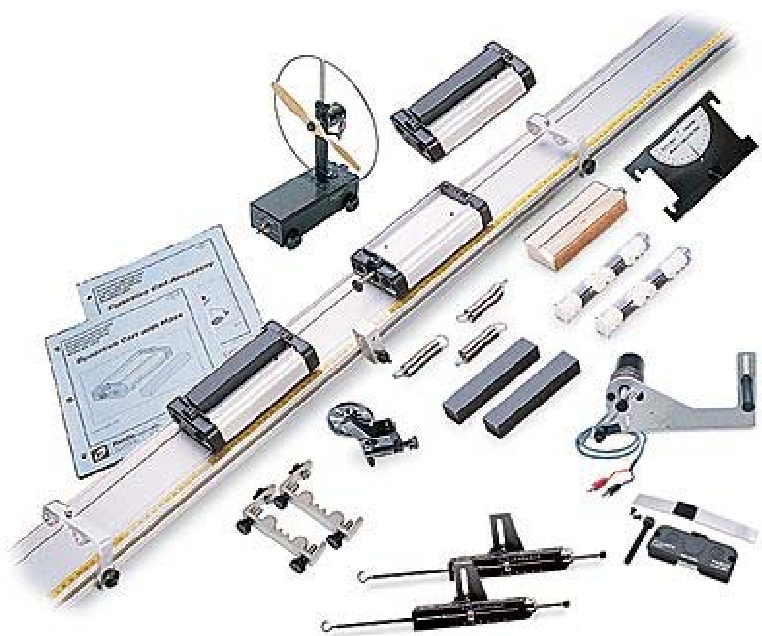
M91: Pasco Computerized Gyroscope

M01: Pasco Dynamics Track

Purpose: to demonstrate the kinetic and dynamic motion of objects

Description: The track consists of a variety of low friction carts and accessories to allow for the demonstration of many common motion concepts. The system is not a low friction as an air track but is much simpler to set up and use. Below are a few options that are available but the system is not limited to these suggestions. Also a list of specific demonstrations that use this system are listed below for reference.

1. A fan cart to show the effects of an accelerating force. The fan can be angle to show vector components. There is a sail to show the effects of the impulse of the air on the sail.
2. A mechanical driver that can set up oscillations of the carts with spring attached.
3. A spring loaded launcher to give consistant launching impulses.
4. Bumpers for various types of collision and velcro to allow the carts to stick together.
5. A friction pad to give the carts a consistant fritional force.



See the Pasco manual for other ideas for this systems use.

Demonstrations that use the Pasco Dynamics Track: M38, M60, M61, F51 and others that are in development.

Equipment List | **Storage Location**

Equipment List	Storage Location
Track	**F3.3 (CHEMP 130A map)**
Carts and Accessories	**D1 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M01 **Setup Notes:** M01 PIRA #:

Manufacturer(s): Pasco Scienctific # ME-9490 Other school's Demonstration web pages

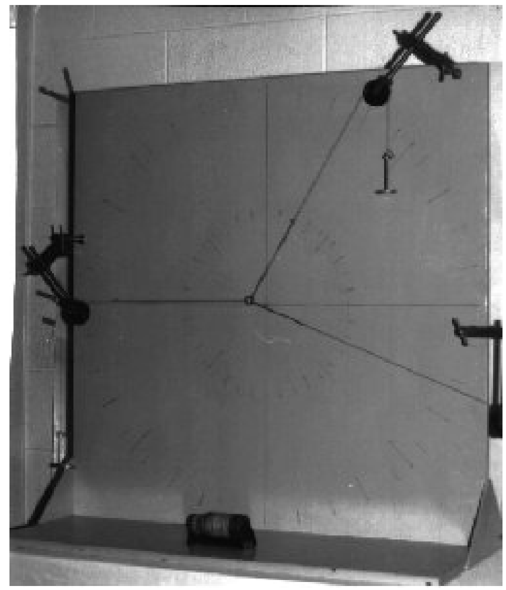
M04: Equilibrium of Forces

Purpose: To demonstrate that the vector sum of the forces on a body in equilibrium is zero.

Description:

A board mounted vertically, and having pulleys attached so that forces can be exerted on a metal ring at any desired angle. Angles are indicated on a coordinate system on the board.

After hanging a thread and weight holder over each of the three pulleys, add weights until the metal ring is in equilibrium at the center of the board. Treating two of the weights as know, and using the measured angles, calculate the third weight. Compare with the experimental value. If desired, repeat using different angles.



Equipment List	Storage Location
Force board	F1.4 **(CHEMP 130A map)**
Mass set and hangers	I2

References: **Manual:** none **Teaching Suggestions:** M04 **Setup Notes:** M04 PIRA #:

Manufacturer(s): VT Other school's Demonstration web pages

M05: Methods for Measuring Motion

Purpose: To measure motion in various situations

Description:

Sonic Motion detector

The sonic motion detector is very useful in measuring the motion of objects in real time when a sting can not be attached to the object. It is limited in its resolution to a few centimeters which is usually good for most qualitative and many quantitative demonstrations.

Demonstrations used in: M01, M81, M82, M87,

Photogates

Photogates can give very accurate measurements of the time that an object takes to passes through the gate.

Demonstrations used in: M24,

Rotary Motion Sensor

The rotary motion sensor can measure angular motion to 0.25 degrees. If a string is wrapped around the pulley the distance moved can be resolved to better than 1 millimeter.

Demonstrations used in: M78, M79, M84, M91, F09, H58,

Equipment List	**Storage Location**
Sonic Motion detector	**D1 (CHEMP 130A map)**
Photogates	**D1 (CHEMP 130A map)**
Rotary Motion Sensor	**D1 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M05 **Setup Notes:** M05 PIRA #:

Manufacturer(s): Pasco Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

M09: Hover Puck

Purpose: To show low friction motion.

Description:

The Hover Puck glides on a self-generated cushion of air across any smooth surface. The rubber bumper provides protection for the puck and other objects during collisions.

Inertia Activities -- The Hover Puck removes friction from its motion, which helps students better understand Newton's First Law

Newton's Second Law -- Students can apply various forces to the puck and record its acceleration with a Motion Sensor

Equipment List

Hover Puck

Storage Location

D1.6 (CHEMP 130A map)

References: **Manual:** **Teaching Suggestions:** M09 **Setup Notes:** M09 PIRA #:

Manufacturer(s): Pasco Scienctific # SE-7335A

Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

M10: Newton's First Law-Table Cloth Trick

Purpose: To illustrate that if (almost) no force is exerted on an object, there is (almost) no acceleration of the object.

Description:

Have the tablecloth and place setting fixed on the table before class starts. Make up a fiction of your choice about why a person might need the tablecloth removed before removing the dishes from the table. (For example, the roommate in charge of laundry might want to wash the tablecloth before the lazy roommate in charge of dishwashing removes the dishes.) Point out the advantages of using Newton's first law of motion in such a situation.

Grab the tablecloth with both hands; pull down firmly and sharply. With practice, you can get the tablecloth to come out and leave the dishes very nearly at rest.

Before

During

After

Equipment List

Tablecloth and place setting

Storage Location

D5.3 (CHEMP 130A map)

References: **Manual:** **Teaching Suggestions:** M10 **Setup Notes:** M10 PIRA #: 1F20.30

Manufacturer(s): VT

Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

M11: Inertia Ball

Purpose: Show the Surprising Effect of an Impulse Load on a Large Inertial Mass.

Description:

Suspend this heavy cast iron ball by one of its eyes using lightweight cord. To the lower eye, tie another piece of the same cord, then jerk down hard on that bottom cord. Then, replace the cord that breaks with fresh cord and pull down on the bottom cord slowly but gently. The results reveal worlds about inertia. The enameled iron sphere comes with two eyes mounted at the opposite ends of a diameter and a third eye for a safety cord to prevent the ball from falling.

Equipment List	**Storage Location**
Inertia Ball	**D5.3 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M11 **Setup Notes:** M11 PIRA #:

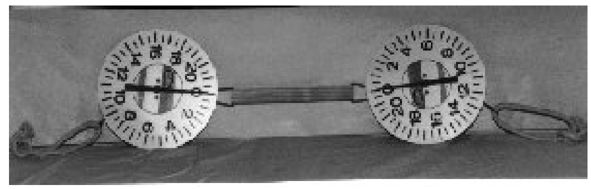
Manufacturer(s): Sargent-Welch # CP00751-50 Other school's Demonstration web pages

M12: Newton's Third Law-Opposing Scales

Purpose: To demonstrate that for every action there must be an opposite reaction.

Description:

Two spring balances attached to cords. A computerized version of this demonstration is currently under development.



With the instructor holding the center board, ask Student A to pull with a force of 6 N and Student B with a force of 12 N. The instructor then releases the center board and asks Students A and B to repeat the readings.

Equipment List | **Storage Location**

Opposing Scales | **D5.3 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M12 **Setup Notes:** M12 PIRA #: 1H10

Manufacturer(s): VT

Other school's Demonstration web pages

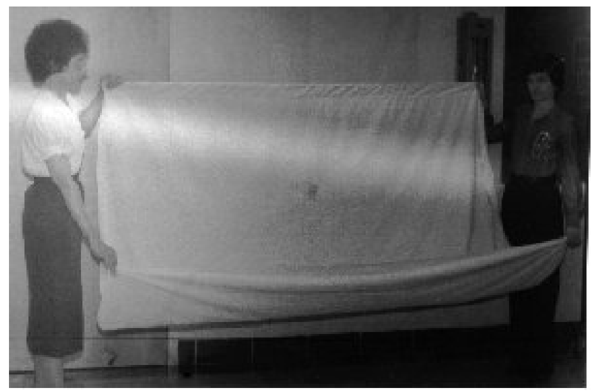
M20: Egg and Sheet

Purpose: To illustrate

1. Newton's second law
2. Work-energy principle
3. Impulse-momentum principle

Description:

Have a student assist you in holding the sheet in a "J" fashion as shown. Invite another to throw the raw egg as hard as possible at the sheet. The valley in the sheet must be held so that it catches the egg before it falls to the floor. Break the egg into a cup to show that it is not hard-boiled. A small water balloon is nice alternative to a raw egg just incase you miss the sheet.



Equipment List

A bed sheet with a rigid board attached to one edge and a raw egg. The raw egg is provided by the instructor.

Storage Location

F6 (CHEMP 130A map)

References: **Manual:** **Teaching Suggestions:** M20 **Setup Notes:** M20 PIRA #: 1N10.20

Manufacturer(s): Other school's Demonstration web pages

M24: Air Track- Velocity and Acceleration

Purpose: To illustrate concepts of velocity with quantitative measurements. Illustrate concept of acceleration using relation $v^2 = 2as$. Determine acceleration due to gravity.

Description: Instrumented air track.

Velocity of cart is determined by dividing the length d of a light-obscuring plate by the time t that the light remains obscured (v=d/t). The time is measured with the Pasco 750 interface. These accurate determinations of velocity are then used to show acceleration.

1. Down load the DataStudio setup file 'M24_1.ds' to the desktop of the lecture computer. Start the Pasco DataStudio software by double clicking the setup file. Test operation of the electronics by interposing hand between light source and photo-sensitive diode. There is a red LED on each of the photogates that will light when the gate is blocked. Explain operation to class and how to calculate velocity of cart.
2. Turn on blower and show from computer readings that cart retains nearly constant velocity.
3. Raise one end of track using the elevation block and place the photogates 60 cm and 160 cm from start. Release cart and determine velocity at S=60 cm and S=160 cm. Calculate accelerations from $v^2 = 2as$.

Equipment List	**Storage Location**
Pasco air track, carts, elevation blocks, photogates	**F4.3 (CHEMP 130A map)**
Pasco Air Blower	**Lecture 2 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M24 **Setup Notes:** M24 PIRA #: 1F30.10

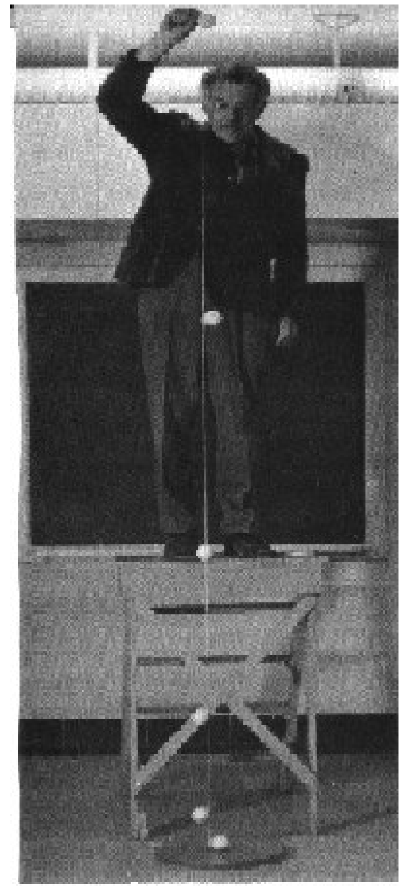
Manufacturer(s): Pasco Other school's Demonstration web pages

M28: Falling Bodies

Purpose: To demonstrate the relation $y = (1/2)gt^2$.

Description:

The apparatus consists of a cord approximately 3.5 m long with weights tied to it at such spacings to produce constant time intervals between the sounds of the weights hitting the floor. The length of the cord is about 3.5 m and the spacings of the weights are calculated to produce a time interval of 0.15 sec.



The class should first be shown that the weights are distant from the bottom y according to the relation $y = (1/2)gt^2$ for Dt = 0.15 sec. Thus, since t = Sum[$(Dt)_i$], the following table shows the predicted y values for constant Dt:

t (sec)	y (cm)
0.00	0
0.15	11
0.30	44
0.45	99
0.60	176
0.75	276

Stand on the desk and hang the cord over a pie tin. When released, the sound of the weights hitting the tin will occur at constant intervals.

Equipment List

Storage Location

D5.3 **(CHEMP 130A map)**

References: **Manual: none** **Teaching Suggestions:** M28 **Setup Notes:** M28 PIRA #:

Manufacturer(s): VT

Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

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M32: Feather and Coin

Purpose: To show that the acceleration due to gravity is independent of the mass.

Description: Long glass tube with a feather and a coin inside; vacuum pump.

First show the rates at which the coin and feather fall in air just by tipping the glass tube. Then evacuate the tube using the vacuum pump and again show the rate of falling.

Equipment List	**Storage Location**
Tube with feather and plastic disk	**F1.3 (CHEMP 130A map)**
vacuum pump	**Lecture 2 (CHEMP 130A map)**

References: **Manual: none** **Teaching Suggestions:** M32 **Setup Notes:** M32 PIRA #: 1C20.10

Manufacturer(s): Other school's Demonstration web pages

M34: Air Drag

Purpose: To demonstrate air drag quantitatively, and to show that the drag force is quadratic in the speed for a light object with a large ratio of frontal area to height.

Description:

Some textbooks claim that the drag force is linearly proportional to the speed of a particle, some state the variation to be quadratic, while others indicate the drag to be linear at low speeds and become quadratic at higher speeds. This demonstration shows that, even at low speeds, the force is quadratic in speed if the object has sufficient frontal area that the flow around the edges is turbulent (corresponding to large Reynolds numbers). The transverse air speeds for such an object are not low.

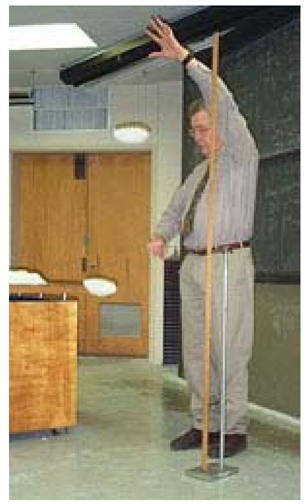
(1) Linear drag force: If the drag force, D, is linear in speed, v, then $D = kv$ leads to terminal speed $v_t = mg/k$. In time, T, the object falls through height $h = (mg/k)T$. Thus, objects with masses m_1 and m_2 falling over the same time interval, T, drop distances h_1 and h_2 in direct proportion to their masses. That is,

$h_1/h_2 = m_1/m_2$. [Equation 1]

(2) Quadratic drag force: A similar treatment using $D = kv^2$ leads to:

$h_1/h_2 = (m_1/m_2)^{1/2}$. [Equation 2]

See the teaching notes for more details on the calculations and use of this demonstrations.



Equipment List | **Storage Location**

Several coffee filters, a two-meter stick held vertically, and a piece of chalk. **D5.3 (CHEMP 130A map)**

References: **Manual: none** **Teaching Suggestions:** M34 **Setup Notes:** M34 PIRA #: unknown

Manufacturer(s): VT Other school's Demonstration web pages

Teaching Suggestions for M34: Air Drag

This demonstration tests the above equations (1 and 2) and depends on the assumption (valid for very small mass and large cross section) that the entire fall takes place at terminal speed. Demonstrate this effect by dropping one or more stacked coffee filters (bottom down) from a height of 2.0 m and notice that each 50 cm of fall takes the same time (for a given mass of filters).

1) Check for linear drag force: If the drag force is linear, and Equation 1 applies, then one coffee filter dropped from a certain height should have the same fall time as two filters dropped from twice that height. Hold two stacked filters at the top of the 2.0-m stick and one filter at the 1.0-m midpoint. Drop them simultaneously. Note that they do not land at the same time. Thus the drag force is not linear.

(2) Check for quadratic drag force: For a quadratic force, Equation 2 should apply. Thus 4 filters dropped from 2.0 m should fall in the same time as 1 filter dropped from 1.0 m. Drop the filters accordingly and they should land at very nearly the same time, confirming that the force is very nearly quadratic.

(3) Further confirmation of quadratic force: You might ask the students where one filter should be placed to reach the floor at the same time as two filters dropped from 2.0 meters. They should conclude that $h_1 = 0.707h_2$, or 1.41 m. Test this conclusion. How many filters would fall from three times the height as one filter? Test the hypothesis by simultaneously dropping nine from 2.0 m and one from 0.67 m.

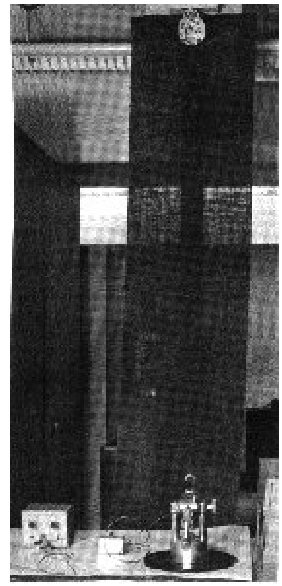
Caution: Be sure there is no breeze in the area in which the filters are being dropped. Faulty results may occur otherwise. Also, you will probably get better results if you use stacks of 2, 4, and 9 filters that have been removed from their package together so that each stack has approximately the same size and shape as the single filter

If you have any suggestions or need any help with this demonstration contact Clark Snelgrove at crsnel@vt.edu

M36: Monkey and Hunter

Purpose: To demonstrate that vertical acceleration is independent of horizontal motion.

Description:



A spring actuated gun aimed at a model of a monkey suspended by an electromagnet near the ceiling. When the gun fires a 1.9 cm ball bearing, it opens the electromagnet circuit, thus releasing the "monkey." Since the acceleration downward of the monkey and the ball are the same, the ball's parabolic trajectory and the monkey's vertical trajectory meet near the floor.

Explain that when the monkey sees that the gun is aimed at him, he decides to fool the hunter by letting go at the instant he sees the flash of the gun. This, of course, is a grave error due to his ignorance of the independence of vertical and horizontal motion.

Instruction in the use of this equipment and practice ahead of time are essential.

Equipment List	**Storage Location**
spring actuated gun, and power supply for electromagnet	**D2.4 (CHEMP 130A map)**
electromagnet on support pole with backdrop	**F6 (CHEMP 130A map)**

References: **Manual: none** **Teaching Suggestions:** M36 **Setup Notes:** M36 PIRA #: 1D60.30

Manufacturer(s):

Other school's Demonstration web pages

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

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M38: Ballistic Cart

Purpose: To demonstrate that the horizontal motion of a projectile is independent of vertical forces on it.

Description: A launcher on a cart fires a ball vertically as it pass a trigger point. Since the cart and the ball both have the same horizontal motion the ball lands back in the launcher. The drop rod can also be used to drop a ball into the laucher as the cart passes the trigger point. See the teaching notes for how to do this.

Turn on the power to the ballistic cart and push down on the yellow ball to engage the spring that launches the ball. Fire the ball with the cart at rest by passing a piece of paper through the photogate. Notice that it falls back into the cart. Then load the ball in the cart and give the cart a modest push along the track. As it passes the post, the flag breaks the beam in the photogate, and the ball releases. The ball should rise and fall back into the moving car. Demonstrate for various speeds. If you elevate one end of the track and let the cart accelerate past the flag, the ball still falls into the cart because both ball and cart experience the same component of acceleration parallel to the track. **Caution: Be sure the track is level side-to-side. There are adjustment knobs on two sides of the cart to correct the aiming.**

Equipment List	Storage Location
Pasco ballistic cart with balls	**D1.4 (CHEMP 130A map)**
Pasco Dynamic track	**F4.3 (CHEMP 130A map)**

References: **Manual:** **Teaching Suggestions:** M38 **Setup Notes:** M38 PIRA #: 1D60.10

Manufacturer(s): **Pasco Scientific # ME-9486** Other school's Demonstration web pages

Teaching Suggestions for M38: Ballistic Cart

This is the configuration for the using the drop rod. The ball is dropped from the rod as the cart passes the trigger point. since the ball and the cart both have the same initial velocity the ball falls directly into the launcher. This demonstration is also a very good discussion builder for Galilean relativity.

If you have any suggestions or need any help with this demonstration contact Clark Snelgrove at [crsnel@vt.edu]

M42: Dynamics of Circular Motion

Purpose: To introduce the dynamics of circular motion.

Description: A platform with strings attached at the corners, three plastic cups, container of water.

To introduce the topic, pour water into one plastic cup and ask students who can turn it upside down without anything over the top of the cup, and not have the water come out. Some will suggest swinging it. Invite one to come up and demonstrate. Then fill the other cups and invite the student to "turn over" all three at once. Offer the use of the platform. Generally the volunteer will be able to swing the platform and cups in a vertical circle, and stop them, without spilling (much) water.

A qualitative explanation can be based on Newton's first law, by making note of the fact that the water at the top of the circle would tend to go in nearly a straight line. The curved path of the cup causes it to pull down on the water, forcing it to stay inside.

Subsequently, estimate the radius of the circle and calculate, using Newton's second law of motion, the minimum speed for the cup at the top of the circle if the water is to remain in the cup.

Equipment List

A platform with strings attached at the corners, three plastic cups, container of water.

Storage Location

D5.4 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M42 **Setup Notes:** M42 PIRA #: 1D50.40

Manufacturer(s): VT

Other school's Demonstration web pages

M45: Air Table Collisions

Purpose: To demonstrate two dimenstional motion

Description: Pucks are levitated on a cushion of air to simulate very low friction motion.

The motion can be demonstrated qualitativly by simply pushing the pucks by hand and allowing the students to see the motion.

There are a large combination of various pucks that can be used to illustratate various motions and collisions. See the teaching notes for more details.

Quantitative measurements can be made by capturing the motion on video tape and then using the VideoPoint software to analyise the data.

Equipment List	**Storage Location**
Air table	**F6** CHEMP 130A
Air blower	**Lecture 2** CHEMP 130A
Air table pucks and accessories	**D3.1** CHEMP 130A

References: **Manual: none** **Teaching Suggestions:** M45 **Setup Notes:** M45 PIRA #:

Manufacturer(s): Ealing Other school's Demonstration web pages

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Teaching Suggestions for M45: Air Table Collisions

There two magnetic pucks that will give a very good elestic collision.

There are large pucks that can collide with large or small pucks. There are pucks that have velcro on the edges so that thye will stick together for inelestic collisions.

If you have any suggestions or need any help with this demonstration contact Clark Snelgrove at crsnel@vt.edu

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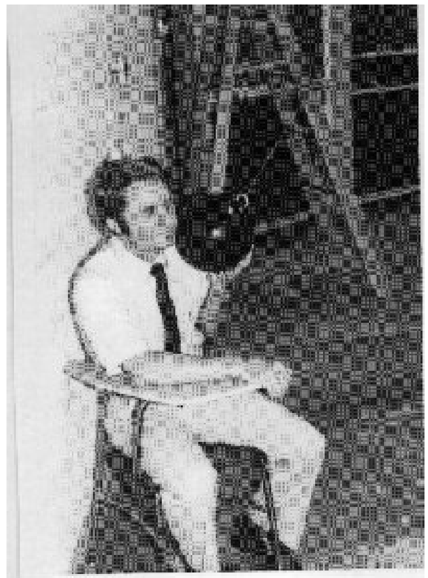
M50: Nose Basher

Purpose: To display the principle of conservation of energy by the use of a large pendulum.

Description: Bowling ball hanging by a chain from the ceiling.

Suspend the bowling ball from the hook on the ceiling. Sit on a chair at a location such that, when the bowling ball is displaced from equilibrium to the height of your head, it is touching your face. Release the bowling ball to swing across the room. Hold your head very still so that the ball comes back and almost collides with your face.



Equipment List

Storage Location

D5.6 **CHEMP 130A**

References: **Manual: None** **Teaching Suggestions:** M50 **Setup Notes:** L13 PIRA #: 1M40.10

Manufacturer(s): VT

Other school's Demonstration web pages

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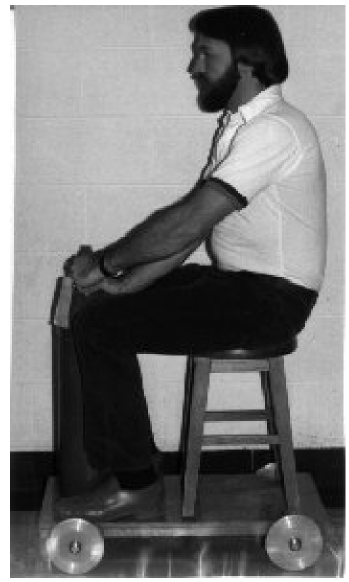
M55: Carbon Dioxide Rocket Cart

Purpose: To demonstrates the recoil from a stream of released gas.

Description: The apparatus consists of a cart and stool and a fully charged fire extinguisher tank of CO_2.

Aim cart for maximum travel, make arrangements for a student to catch you, sit on stool as shown and open the valve on the tank.



Equipment List

Storage Location

F4.4 CHEMP 130A

References: **Manual: none** **Teaching Suggestions:** M55 **Setup Notes:** M55 PIRA #: 1N22.10

Manufacturer(s): VT

Other school's Demonstration web pages

M56: Low Friction Game of Catch

Purpose:

Description:

Equipment List | **Storage Location**

Medicine ball | **D4.1** CHEMP 130A

Carts | **STAIRS** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M56 **Setup Notes:** M56 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

M58: Balls for Bouncing Collisions

Purpose:

Description: A set of various balls that can be used to demonstrate bouncing collisions

Equipment List

Storage Location

D5 **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M58 **Setup Notes:** M58 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

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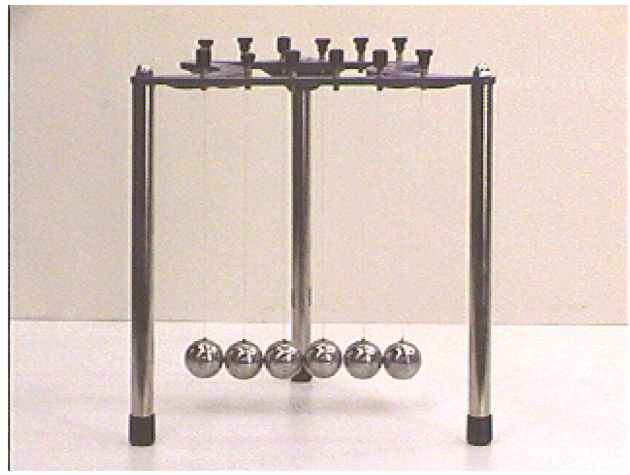
M59: Collision of Balls

Purpose: To demonstrate conservation of energy and conservation of linear momentum in multiple elastic collisions.

Description: To start, hold one, two, three, or four balls to the side and release. Symmetric oscillations result from conservation of energy and conservation of linear momentum in the collision sequence.



Equipment List **Storage Location**

D4 **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M59 **Setup Notes:** M59 PIRA #: 1N30.10

Manufacturer(s): Other school's Demonstration web pages

M60: Frictional Properties of Materials

Purpose: To demonstrate how to find the coefficient of static friction of different materials.

Description: Pasco track with incline accessory, string, weights, and friction boxs with different surfaces.

Set up apparatus as shown in photo and then place weights on pulley system until the block begins to slide. Measure the components of the gravitational force with the help of the protractor. Then calculate the coefficient of friction. Repeat procedure with another friction box with a different surface materials.

Equipment List	**Storage Location**
Pasco track with inclined accessory	**F3.3 CHEMP 130A**
Friction boxes with different surfaces (see the teaching notes for a list of the different materials)	**D4.3 CHEMP 130A**
weights and string	**I2 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M60 **Setup Notes:** M60 PIRA #: 1K20.10

Manufacturer(s): Cenco (Sargent-Welch) Other school's Demonstration web pages

Teaching Suggestions for M60: Frictional Properties of Materials

The photos shows the different types of friction boxes. The boxes have different surface materials for measuring different coefiecients of friction. the boxes can also be loaded with different amount of mass to change the weight of the box.

The materials on the friction boxes are:

1. 2 boxes with Plastic (polyproplene?)
2. felt
3. cork

If you have any suggestions or need any help with this demonstration contact Clark Snelgrove at crsnel@vt.edu

M61: Inclined Plane Problems

Purpose: To demonstrate various inclined plane problems that are typical in introductory textbooks.

Description: Pasco Track with incline accessory

Problem 1: Finding the components of the forces.

Problem 2:

See the teaching suggestions for how to use these problems as an interactive lecture demonstrations.

Equipment List	**Storage Location**
Pasco Track with incline accessory	**F3.3** **CHEMP 130A**
Pasco Collision cart	**D1.3** **CHEMP 130A**
string, weights	**I2** **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M61 **Setup Notes:** M61 PIRA #: 1K20.10

Manufacturer(s): Pasco Scientific, VT Other school's Demonstration web pages

Setup Instructions for M61: Inclined Plane Problems

Clamp the track incline accessory to the edge of the table in two places as shown.

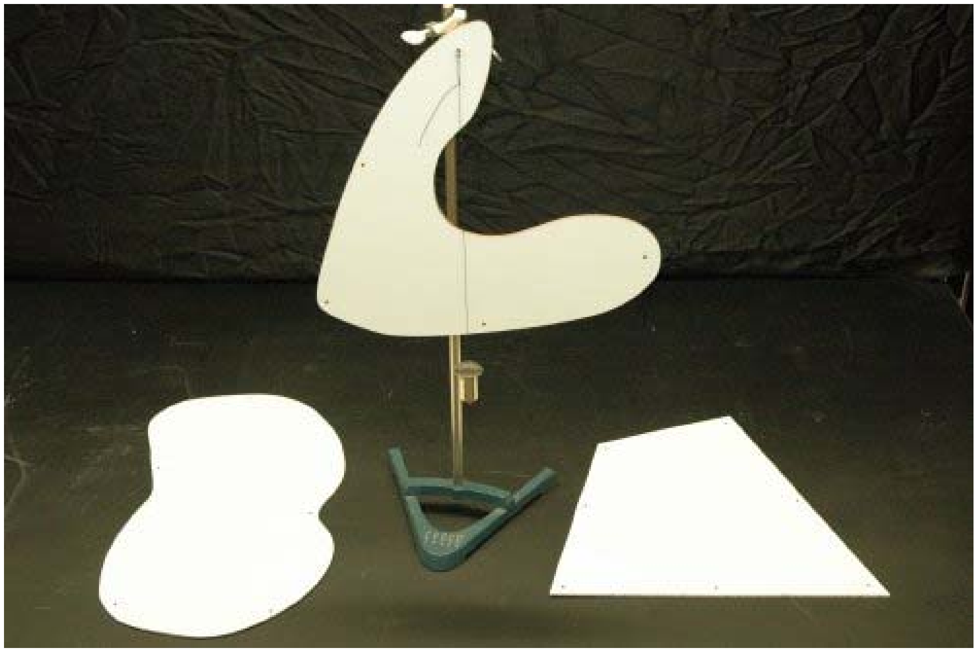
Clamp a small universal clamp to the other end of the table for the elevation clamp. Use a ~2 m rod for elevating the track. Insert the rod into both the table clamp and the clamp on the track. Make sure that the clamp on the table is tight. Keep the track clamp loose until the track is position where desired then tighten it.

If you have any suggestions or need help with this demonstration please contact Clark Snelgrove at crsnel@vt.edu

M64: Center of Gravity

Purpose: To show the ease with which you can find the center of gravity and show that it is the center of rotation.

Description: A few irregular plywood shapes with holes around their edges, a plumb line, brass pivot connected to a stand, and a dry erase marker.



Place the brass pivot through any hole on the edge of the geometric shapes and let it hang from this point. Now tie the plumb line to the brass bar and mark off a line with a dry erase marker along the thread. Repeat this for other holes. Highlight the point of intersection with a red dot.

Play catch with the geometric shape to show that the center of gravity follows a parabolic path. **Be careful to catch the objects so they don't hit the ground. The are made of a material that will not withstand too many impacts with the floor.**

Equipment List	**Storage Location**
Geometric shapes, plumb bob, brass pivot	**D5.4 CHEMP 130A**
Rod stand with threaded rod,	**F6 CHEMP 130A**
right angle clamp	**H3.2 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M64 **Setup Notes:** M64 PIRA #: Map of State

Manufacturer(s): VT

Other school's Demonstration web pages

Setup Instructions for M64: Center of Gravity


If you have any suggestions or need help with this demonstration please contact Clark Snelgrove at crsnel@vt.edu

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

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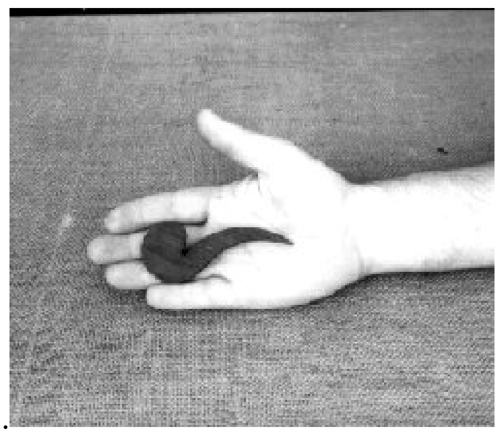
M65: Center of Gravity Toys

Purpose: To exhibit equilibrium of torques and/or center of gravity.

Description: Toys for illustrating center of mass

Sky Hook: Show the sky hook, illustrating that it cannot be supported only under its tip. Remove your belt and insert as shown. Demonstrate that it now can be supported by its tip only. Explain via balanced torques and/or center of gravity of hook-belt system



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Leaning tower:

V shaped ramp:

Equipment List	**Storage Location**
Sky Hook: A comma-shaped piece of wood, a relatively stiff belt.	**D5.4 CHEMP 130A**
Leaning tower:	**D5.4 CHEMP 130A**
V shaped ramp:	**D5.4 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M65 **Setup Notes:** M65 PIRA #:

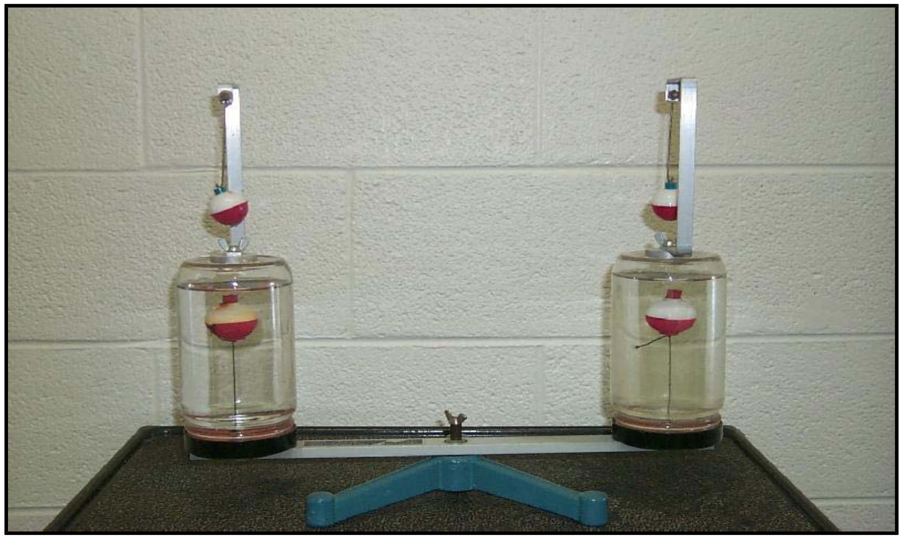
Manufacturer(s): Other school's Demonstration web pages

M70: Central Force Demonstration

Purpose: To demonstrate Newton's second law and Archimedes' principle.

Description: A float suspended in each of two bottles containing a liquid and mounted on the ends of a rotatable rod.

Just rotate apparatus by hand and observe the floats.



Equipment List

Storage Location

D4.3 **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M70 **Setup Notes:** M70 PIRA #:

Manufacturer(s): **Sargent-Welch #WL0922**

Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

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M72: Loop the Loop

Purpose: To demonstrate the idea of energy due to position and also the idea of centripetal force.

Description: Cenco Loop the Loop apparatus with various balls.

Find the spot on the loop-the-loop track where the clear plastic ball will just make it around the loop. Now place the steel ball at the same spot and see that it also just makes it around. If the steel ball is moved any lower it won't make it around (thus demonstrating that the energy needed to traverse the loop depends only on the initial height and not on the mass of the balls). Now place the black plastic ball of diameter 4.3 cm so that it just traverses the loop-the-loop. Then try it with the clear plastic and steel balls at the same spot. These do not make it because their centers of mass are lower and they do not have enough energy.

Equipment List	Storage Location
Track	D2.0 CHEMP 130A
Balls: steel ball 2.5 cm in diameter and a mass of 67 grams, a clear plastic ball 2.5 cm in diameter and a mass of 10 grams; a black plastic ball 4.3 cm in diameter and a mass of 57 grams.	D3.1 CHEMP 130A
Large universal clamp, rod clamp	H3.2 CHEMP 130A
1.5 m rod	F6 CHEMP 130A

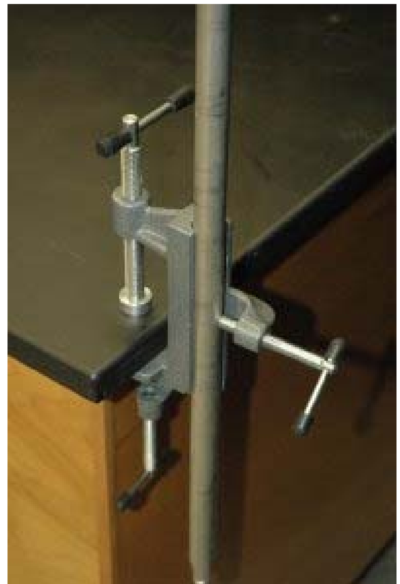
References: **Manual: none** **Teaching Suggestions:** M72 **Setup Notes:** M72 PIRA #: 1M40.20

Manufacturer(s): Cenco (Sargent-Welch) Other school's Demonstration web pages

Setup Instructions for M72: Loop the Loop

Clamp a large universal clamp to the edge of the table and insert a long (1.5 m) rod into the clamp and tighten.

Clamp the top of the track as shown to the right using the rod attached to the track and a rod clamp. Attach this clamp to the top of the 1.5 m long rod. Adjust rods and clamps so that the loop the loop base is level in the table and stable.



If you have any suggestions or need help with this demonstration please contact Clark Snelgrove at crsnel@vt.edu

M73: Rotational Inertia

Purpose: To illustrate that rotational inertia (moment of inertia) depends not only on the mass of an object but also on the mass distribution relative to the axis of rotation.

Description: A Plexiglas tube equipped with weights that can be located anywhere between the center of the tube and the two ends. Thumbscrews hold the weights in place.

With the weights at either the center or the ends, rotate the tube back and forth about an axis perpendicular to the tube. Move the weights to the other extreme position and compare the torque required.

Even though the difference probably will be obvious to the class as the instructor rotates the tube, it perhaps will be more convincing to let a student do the rotating, or maybe it could be handed around for several students to try.

Equipment List

Plexiglas tube equipped with weights

Storage Location

D3.4 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M73 **Setup Notes:** M73 PIRA #: 1Q10.10

Manufacturer(s): VT

Other school's Demonstration web pages

M74: Angular Acceleration-Rolling Bodies

Purpose: To examine the effect of the moment of inertial of various shaped objects as they roll down a ramp.

Description: There is a large collection of various spheres, disks, and hoops that can be raced down the ramp.

Place the various objects on the ramp and release them simultaneously. there is a metal plate to put in front of the objects the make it easier to start them together.. Compare the angular acceleration by comparing the arrival times of different objects that are rolled down the ramp. Comparisons can be made between spheres, disk, and hoops of the same diameter. Comparisons can be made between the same shape object of different sizes.. There is even an object that is not weighted unevenly that only rolls when it is started just right. See the teaching suggestions page for various ways that this demonstrations can be used.

Equipment List	**Storage Location**
Ramp	**D3.0 CHEMP 130A**
Rolling objects (see the teaching suggestions page for a detailed list of all the objects)	**D3.2 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M74 **Setup Notes:** M74 PIRA #: 1Q10.30

Manufacturer(s): VT Other school's Demonstration web pages

Teaching Suggestions for M74: Angular Acceleration-Rolling Bodies

If you have any suggestions or need any help with this demonstration contact Clark Snelgrove at crsnel@vt.edu

Setup Instructions for M74: Angular Acceleration-Rolling Bodies

Use a large universal clamp on the edge of the table. the ramp has a rod attached to it that is inserted into the large table clamp and adjusted to the proper height. Set the ramp at a low angle so that the accellerations are small.

If you have any suggestions or need help with this demonstration please contact Clark Snelgrove at crsnel@vt.edu

M76: Conservation of Angular Momentum

Purpose: To demonstrate conservation of angular momentum.

Description: Rotating stool, weights, bicycle wheel.

1. Sit on the stool with weights in your hands and with your arms extended outward to each side. Start yourself rotating slowly. Then pull the weights in close to your chest. Re-extend and again pull them in.
2. Have a student sit on the stool holding the rotating bicycle wheel with the axis of rotation horizontal.
   Rotate the wheel axis by 90^o about a horizontal axis.
   Rotate back to original position, and then 90^o in the other direction.

Equipment List

Equipment	Storage Location
Weighted wheel	**F4.4 CHEMP 130A**
Rotating stool	**F4.4 CHEMP 130A**
Masses: 2-5 lb bar bells	**D4.3 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M76 **Setup Notes:** M76 PIRA #: 1Q40.30

Manufacturer(s): **Pasco Scientific # ME-6833** Other school's Demonstration web pages

M78: Rotational Platform

Purpose: To demonstrate rotational effects.

Description: PASCO's Complete Rotational System provides a range of experiments in centripetal force, angular momentum and rotational motion.

Equipment List	**Storage Location**
PASCO's Complete Rotational System	**D2.4** **CHEMP 130A**

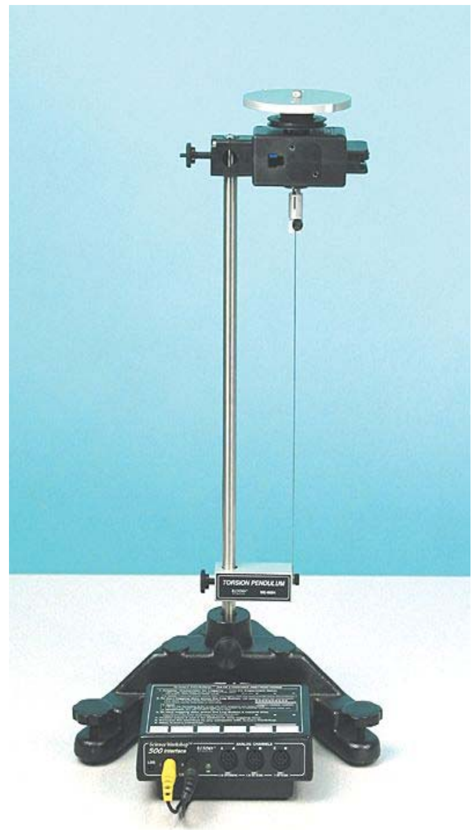
References: **Manual:** **Teaching Suggestions:** M78 **Setup Notes:** M78 PIRA #:

Manufacturer(s): **Pasco Scientific # ME-8950A** Other school's Demonstration web pages

M79: Torsion Pendulum

Purpose: To demonstrate torsional oscillations.

Description: The torsional pendulum consists of a torsion wire attached to a Rotary Motion Sensor with an object (a disk, a ring or a rod with point masses) mounted on top of it.



Equipment List	**Storage Location**
Rotary Motion Sensor	**D2.4** CHEMP 130A
a disk, a ring or a rod with point masses, torsion wire, clamps to hold the wire.	**D2.4** CHEMP 130A
"A" base or other mount with 90cm rod	**F6** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M79 **Setup Notes:** M79 PIRA #:

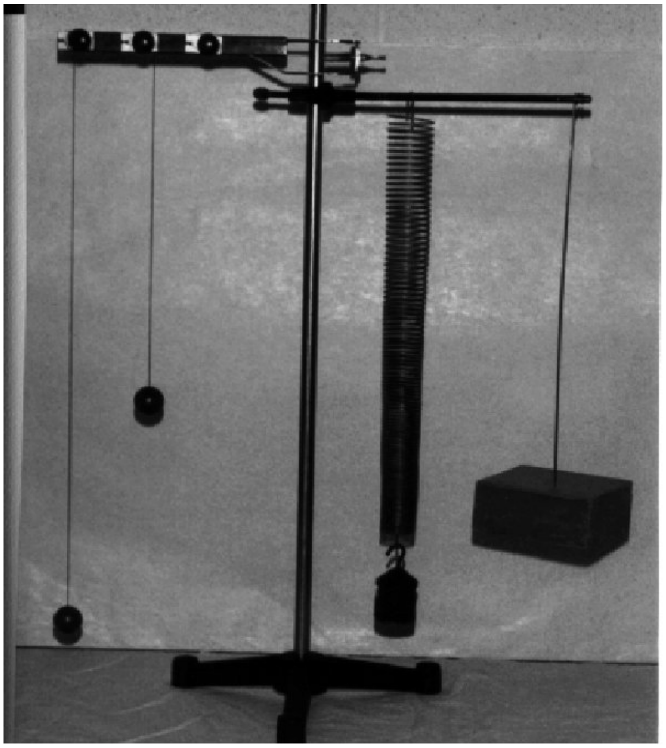
Manufacturer(s): **Pasco Scientific # EX-9903** Other school's Demonstration web pages

M80: Simple Harmonic Motion

Purpose: To provide examples of SHM as aids to the instructor in discussing this topic.

Description: The apparatus consists of a simple pendulum, a torsion pendulum, and a weight on a coil spring to demonstrate transfer of potential to kinetic energy.

Use to illustrate amplitude, phase, frequency, etc. for the various types of SHM.



Equipment List	**Storage Location**
Pendulum clamp with long and short simple pendula	**D4.4** CHEMP 130A
Rod clamp with helical spring with mass and a torsional pendulum	**D4.4** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M80 **Setup Notes:** M80 PIRA #: 3A10.10

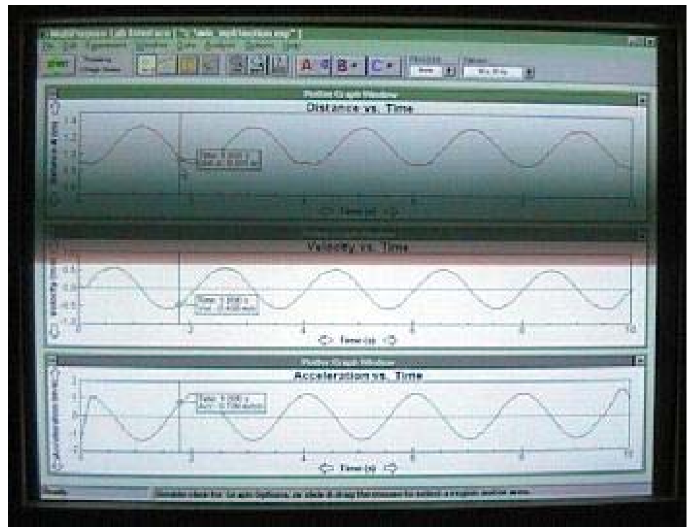
Manufacturer(s): Other school's Demonstration web pages

M81: Simple Harmonic Motion Using the Air Track

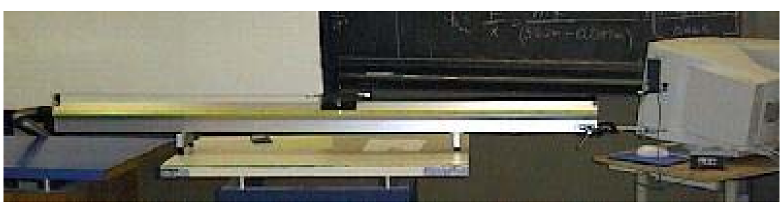
Purpose: To provide a quantitative demonstration of simple harmonic motion.

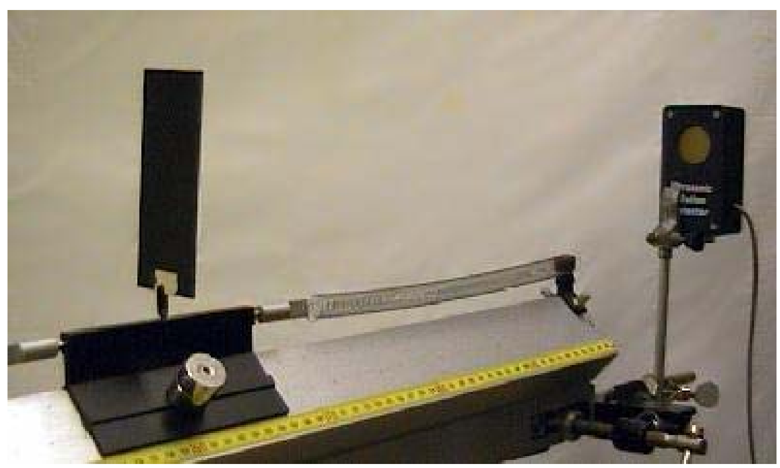
Description: Two-meter air track, cart with springs attached to both ends of the track, ultrasonic motion detector, computer with PascoScienceWorkshop 750 interface and DataStudio software, meter stick.

Start the DataStudio software by copying the file "m81_1.ds" from the demonstration folder on the scratch drive to a location convenient for your use. The file provides a starting window setup (see the photo below) that can be modified. Set the cart into oscillation and click start. The resulting curves of position, velocity, and acceleration give a qualitative description of SHM, and demonstrate the phase differences.



Quantitative: Remove a spring, hang a known mass from it and calculate the spring constant by the distance the mass stretches the spring. The mass of the cart and flag (no weights attached) is 0.212 kg; the optional riders are 50 g each. Calculate the expected period of the motion (remembering that the effective spring constant is twice that for one spring). With the kinematic graphs displayed, click the "x = ?" button, use the mouse to pick points off the graph, and determine the observed period of oscillation. Pray for agreement. (Advance practice with the software is strongly encouraged. If you save the ".ds" file, please use a different name.)





Equipment List | **Storage Location**

Track — **F4.3 CHEMP 130A**

Air Blower — **Lecture1 CHEMP 130A**

Ultra sonic motion detector — **D1.4 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M81 **Setup Notes:** M81 PIRA #: 3A20.30

Manufacturer(s): Other school's Demonstration web pages

M82: Action/Reaction in SHM

Purpose: To illustrate action and reaction in a system oscillating with simple harmonic motion.

Description:

Equipment List	**Storage Location**
Demonstration currently being redeveloped	**D1.4** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M82 **Setup Notes:** M82 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

M83: Reference Circle in Simple Harmonic Motion

Purpose: To show that, for a particle moving in uniform circular motion, its projection on a diameter moves with simple harmonic motion.

Description: A bicycle wheel with a ball attached to its rim and mounted with its axis horizontal, a motor system for driving the wheel in uniform circular motion, a mass/spring system suspended near the wheel. The equilibrium position of the mass should be level with the axis of the wheel. The entire apparatus is placed on a table with swivel casters.

Set the wheel in motion such that its period is the same as that of the mass oscillating on the spring (probably about 395 RPM on the motor). Hold the mass even with the bottom of the wheel, and release it just as the ball passes. (A little practice is necessary!) Viewing from an edge view of the wheel, you should see the ball and spring moving together in simple harmonic motion. Rotate the table slowly so that all class members have a chance to see the system from an edge view of the wheel.

Equipment List	**Storage Location**
Wheel	**F6** CHEMP 130A
Motor	**D4.5** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M83 **Setup Notes:** M83 PIRA #: 3A40.10

Manufacturer(s): Other school's Demonstration web pages

M84: The Physical Pendulum

Purpose: To measure the rotational inertia (moment of inertia) of a physical pendulum and compare it with the calculated value.

Description:

Option 1: A meter stick mounted to pivot about one end, a stop watch or timer.

Option 2: A meter stick mounted to a Rotory Motion Sensor attached to the Pasco 750 interface.

Set the meter stick into small oscillations and measure the time for several (e.g., 5) oscillations. Divide by the number of oscillations to get the period. Starting with the equation for the period of a physical pendulum, solve for the rotational inertia. Then use the measured period to calculate the rotational inertia in terms of the mass of the pendulum. (The distance from the pivot to the center of mass is, of course, 0.5 m.) The rotational inertia of a rod suspended from one end calculates to (1/3)ML2 (for the usual symbols). For a meter stick, this is (1/3)M in appropriate SI units. The experimental measurement described above should give an answer very close to this value.

Equipment List	**Storage Location**
Clamp and pivot	**D4.4 CHEMP 130A**
Rotory Motion Sensor	**D2.4 CHEMP 130A**
Rod stand	**F6 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M84 **Setup Notes:** M84 PIRA #: 3A15.10

Manufacturer(s): VT, Pasco Scientific Other school's Demonstration web pages

M85: Forced Vibrations

Purpose: To demonstrate resonance in forced vibrations.

Description: Mass on a spring that oscillates free, or damped in a tube of water. The system can also be driven a various frequencies and the amplitude of the oscilation measured.

1. Push the oscillator with your hand and watch the natural undamped oscillation.
2. Place the end of the oscillating rod into the cylinder of water. Push the oscillator and watch the damped oscillator.
3. Drive the oscillator by varying the vibration frequency and observe the greatly enhanced vibration near the resonant frequency. Drive the oscillator at about 187 Hz and observe the resonance.

Equipment List **Storage Location**

PASCO Model 9210 driven harmonic motion analyzer **F5.0 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M85 **Setup Notes:** M85 PIRA #: 3A60

Manufacturer(s): PASCO (no longer manufactered) Other school's Demonstration web pages

M86: Coupled Oscillators

Purpose: Demonstrate the transfer of energy between coupled oscillators

Description: Coupled oscillators

Equipment List **Storage Location**

D5.0 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M86 **Setup Notes:** M86 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

M87: Wilberforce Pendulum

Purpose: Demonstrate coupled oscillation modes

Description:

When the Wilberforce Pendulum is initially displaced in the vertical direction, it oscillates in a purely up-and-down motion. The translational oscillation gradually transfers to a purely torsional mode and then back to the translational mode. The translational and torsional periods must be the same. This is accomplished by adjusting the position of the masses on the crossbar.

The motion of the Wilberforce Pendulum can be recorded using DataStudio software. The vertical position, velocity and acceleration are measured with a Motion Sensor placed below the pendulum. A laser and a Laser Switch measure the angular speed in the torsional mode as the spokes of the wheel break the laser beam. The transition between modes can be seen on a graph. A Force Sensor attached to the end of the spring measures the spring force as the pendulum oscillates. The force can be graphed in real-time as a function of position to determine the spring constant and the theoretical period. The period of oscillation is about one second.

Equipment List	**Storage Location**
Pasco Wilberforce Pendulum	**D2.3** **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M87 **Setup Notes:** M87 PIRA #:

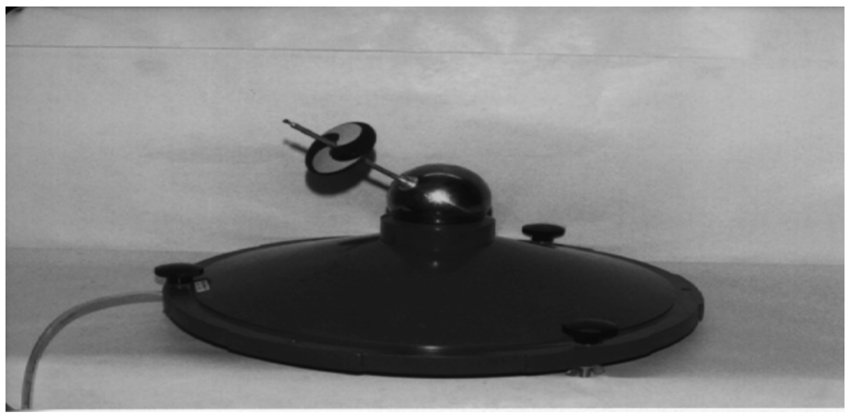
Manufacturer(s): **Pasco Scientific # ME-8091** Other school's Demonstration web pages

M90: Symmetrical Top

Purpose: To demonstrate precession, nutation and gyroscopic stability.

Description: Air-suspended spherical ball with axle for an eccentric spinner; balance ring; and piece of string.

Without the spinner in place, the top is nearly a symmetric sphere and the axle will stay pointed in one direction, even though the table is moved or rotated. With the spinner in place (near the free end of the axle), precession and nutation can be demonstrated. As the top spins slower, the length of the nutation cycle increases and the precession rate is faster. As the top spins faster, the precession rate is slower and the amplitude and period of the nutation cycle both decrease. The nutation may be inhibited by careful hand adjustment of the axle or it may be enhanced by giving the axle tip a push. See Goldstein's



Classical Mechanics for an idea of what's going on.

Forcing the spinner rim to touch against the air suspension table gets the axle to move in the opposite sense from the precession. Other attachments are available for your enlightenment and amusement.

Equipment List **Storage Location**

F1.3 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** M90 **Setup Notes:** M90 PIRA #: 1Q50.45

Manufacturer(s): Other school's Demonstration web pages

M91: Pasco Computerized Gyroscope

Purpose: how gyroscopic effects both qualitativly and quantitativly

Description:

The unique low friction and open design of PASCO's Gyroscope allow studies of rotational motion never before possible with a commercial unit. The completely open design lets students stop precession by grabbing the vertical shaft and observe that the gyroscope dips. Rotational mathematics predicts the dipping action, but it could never be confirmed with the traditional enclosed units.

Equipment List | **Storage Location**

Pasco Computerized Gyroscope | **D2.4 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** M91 **Setup Notes:** M91 PIRA #:

Manufacturer(s): Pasco Scientific #ME-8960 Other school's Demonstration web pages

Fluids

- F01: Computer Based Presure Measurements
- F08: Pacals Vials-Pressure in a Liquid
- F09: Fluid Pressure vs. Depth
- F12: Atmospheric Can Crusher
- F13: Atmospheric Pressure Lift
- F14: Magdeburg Hemispheres
- F20: Archimedes' Principle
- F22: Density Balls
- F23: Cartesian Diver
- F30: Soap Bubble Films
- F34: Surface Tension
- F50: Bernoulli's Principle
- F51: Pasco Bernoulli Cart
- F52: Fan Cart
- F53: Venturi Meter Demonstration
- F60: Acoustic Cannon
- F100: Miscellaneous Supplies

F01 Computer Based Pressure Measurements

Purpose: To display pressure measurements to the class for various demonstrations or to simply show how the computer is used to measure pressure.

Description: Pasco absolute or relative pressure sensor plugged into the Pasco 750 interface.

Pasco Low Pressure Sensor

Pressure Range 0 to 10 kPa (gauge)

Pasco Absolute Pressure Sensor

Pressure Range 0 to 700 kPa (absolute)

Reference Vacuum Pressure 40 mTorr

Equipment List	Storage Location (CHEMP 130A map)
Pasco Low Pressure Sensor-CI-6532A	C5
Pasco Absolute Pressure Sensor-CI-6534A	C5

References:

Manufacturer: Pasco Scientific # CI-6534A , CI-6532A

Manual: online

Teaching Suggestions: F01

Setup Notes: F01

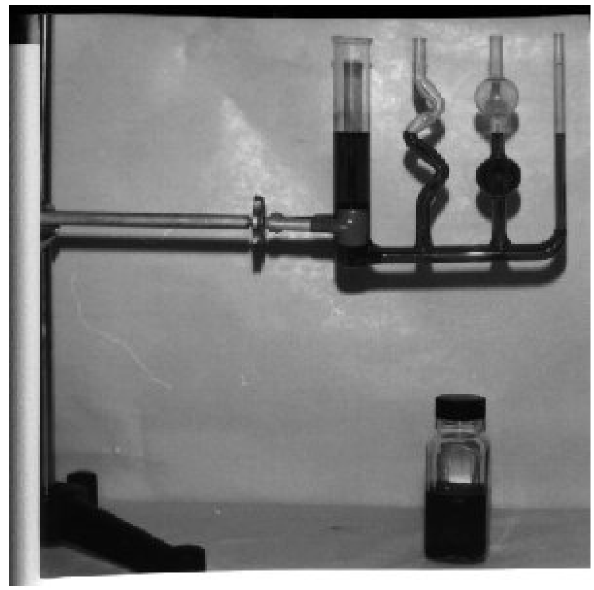
PIRA #:

Demonstration web pages at other schools

F08: Pascal's Vials-Pressure in a Liquid

- **Purpose:** To show that the level of a liquid surface is independent of the shape of the container.
- **Description:** Interconnected tubes of various shapes and sizes, colored water.

Pour the liquid into one of the tubes and show that the liquid level becomes the same in all independent of the shape of the tube. The current version of this demonstration is small. A close-up camera would make it more visible to a large class.



- **Equipment List** — **Storage Location (CHEMP 130A map)**

Equipment	Storage Location
Pascal's Vials	**C4.2**
Colored liquid	**C4.2**

- **References:**

Manufacturer: Sargent-Welch #

Manual: none

Teaching Suggestions: F08

Setup Notes: F08

PIRA #:

Demonstration web pages at other schools

F09 Fluid Pressure vs. Depth

Purpose: To demonstrate the relationship between the pressure in fluid and the depth of the fluid.

Description:

Equipment List

Pressure sensor attached to computer.

Tube to insert into the fluid.

Storage Location (CHEMP 130A map)

This demo is not currently available

References:

Manufacturer:

Manual:

Teaching Suggestions: F09

Setup Notes: F09

PIRA #:

Demonstration web pages at other schools

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

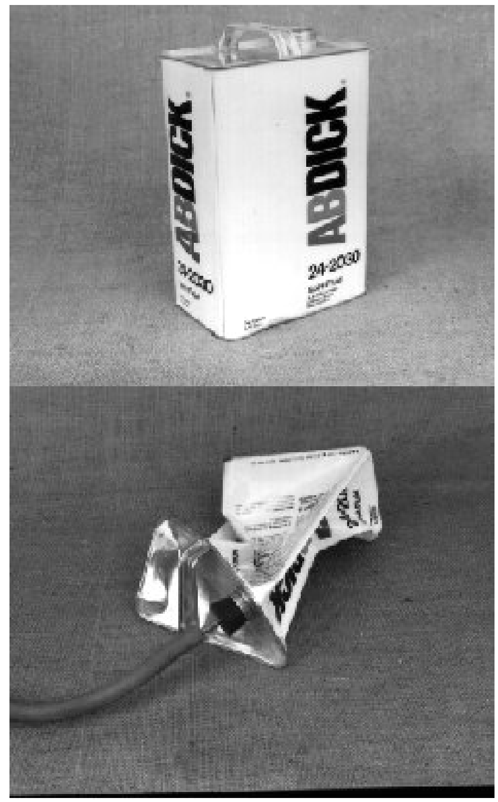
Virginia Tech Physics | Previous Demonstration | Next Demonstration | Lecture demo list

F12: Atmospheric Can Crusher

Purpose: To demonstrate the effect of atmospheric pressure.

Description: Rectangular steel can, vacuum pump, hand-operated air pump or compressed-gas cylinder.

1. Insert the stopper into the can, connect the hose, and pump the air out. The result is usually very impressive.
2. Use the hand-operated pump to pressurize and return the can nearly to its original shape. Alternatively, pressurize by slowly and carefully injecting gas from a compressed-gas cylinder.



Equipment List

	Storage Location (CHEMP 130A map)
Rectangular stell can	**C5.5, extra cans C5.0**
vacuum pump	**Lecture Table 2**
Rubber hose with stopper	**C5.5**

References:

Manufacturer: VT

Manual: none

Teaching Suggestions: F12

Setup Notes: F12

PIRA #:

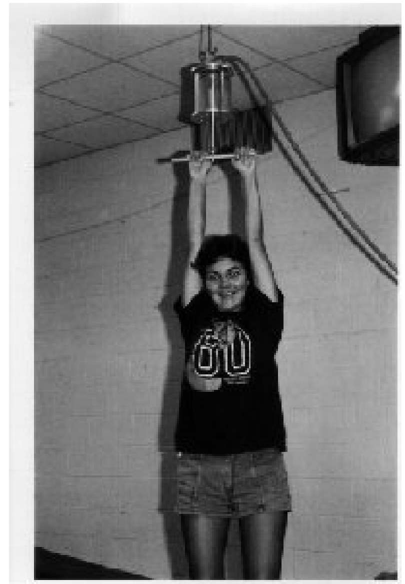
Demonstration web pages at other schools

F13: Atmospheric Pressure Lift

Purpose: To illustrate the force on a small area exposed to atmospheric pressure.

Description:

Vacuum pump, lifting device suspended from the ceiling and consisting of a transparent cylinder with a moveable piston.



Have a student of mass less than about 90 kg hang by his or her arms from the bar attached to the piston. Turn on the vacuum pump and the student should be lifted. (**CAUTION:** Be sure the vacuum hose is not kinked.)

The piston diameter is 11.57 cm. Calculate the maximum possible lift (atmospheric pressure is about 100 kN/m^2). Try lifting a person whose weight exceeds this amount.

Equipment List

Vacumm lifting cylinder

vacuum pump

Storage Location (CHEMP 130A map)

C5.3

Lecture Table 2

References:

Manufacturer: VT

Manual: none

Teaching Suggestions: F13

Setup Notes: F13

PIRA #:

Demonstration web pages at other schools

F14 Magdeburg Hemishperes

Purpose: To show the large force that is exerted by the atmosphere on two disks.

Description: Employs Guericke's Method for Demonstrating the Force of Atmospheric Pressure

Two plastic, 10cm-diameter hemispheres, each with a sturdy handle, make up this device. One hemisphere has a gasket seal; the other has a stopcock for attaching to 0.8-1.2cm inner-diameter vacuum tubing. Join the hemispheres, hook them up to a vacuum pump, and evacuate them. Students will find it hard, if not impossible, to pull them apart. Open the stopcock to let air in, and the hemispheres separate easily.

Equipment List	**Storage Location (CHEMP 130A map)**
Magdeburg Hemishperes	**C5**
vacuum pump	**Lecture Table 2**

References:

Manufacturer: Sargent-Welch # WL1509A

Manual: none

Teaching Suggestions: F14

Setup Notes: F14

PIRA #:

Demonstration web pages at other schools

F20: Archimedes' Principle

Purpose: To demonstrate Archimedes' principle.

Description:

A. Submerged body. Fill the spouted beaker with water until it is on the verge of overflowing through the spout. Place an empty beaker under the spout. Show the class that the cylinder just fits inside the can. Hang the can from the spring balance, and hang the solid cylinder by the short chain from the bottom of the can. Have the class note the weight of the can and cylinder (the balance is calibrated in Newtons). Holding the top of the balance, lower the cylinder into the water until it is submerged and water stops running out of the spout. Note the apparent weight. Pour water from the small beaker into the can; notice that (1) it exactly fills the can, and (2) the scale reads the same as it did with the cylinder outside the water.

B. Floating body. Arrange the water level and small empty beaker as initially in part A. Hang the can only from the balance and note its weight. Hold the balance by its top and lower the can into the water until it floats. Note that the apparent weight goes to zero. Raise the can out of the water, pour the water from the small beaker into the can, and note that the combined weight of water and can is twice the can's weight.

Equipment List	Storage Location (CHEMP 130A map)
Solid metal cylinder that fits snugly into a metal can	**C4.4**
small chain a few centimeters long	**C4.4**
spring balance	**C4.4**
beaker with spout; smaller beaker	**C4.4**

References:

Manufacturer: unknown

Manual: none

Teaching Suggestions: F20

Setup Notes: F14

PIRA #:

Demonstration web pages at other schools

F22: Density Balls

Purpose: To show the change in density of water due to (a) a change in its salinity, and (b) a change in its temperature.

Description:

1. Place a density ball in 60 grams/liter salt solution and watch it float; then place it in fresh water and watch it sink.
2. Place a density ball in water at approximately 45^{o}C. The ball sinks (specific gravity of water 0.990). Again, place the ball in water at a temperature of 15^{o}C and water it float (specific gravity of water 0.999).

See H09: Galileo's Thermometer for another similar demonstraton.

Equipment List

Two density balls

NaCl 60 grams/liter

three beakers

Storage Location (CHEMP 130A map)

C4.4

References:

Manufacturer: Sargent-Welch #

Manual:

Teaching Suggestions: F22

Setup Notes: F22

PIRA #:

Demonstration web pages at other schools

F23: Cartesian Diver

Purpose: To shown that an increase in pressure on a fluid is uniformly distributed throughout the fluid (Pascal's Principle). To Show the principle of bouncy.

Description: Cartesian diver

Press on the diaphram covering the top of the jar to increase the pressure on the water inside the jar. This forces water into the diver and increases its density. The diver then sinks. Releasing the pressure on the diaphram allows the diver to float to the top. This demonstration is small and may be best seen using a close-up camera.

Equipment List

Cartesian diver

Storage Location (CHEMP 130A map)

C4.1

References:

Manufacturer: unknown

Manual: none

Teaching Suggestions: F23

Setup Notes: F23

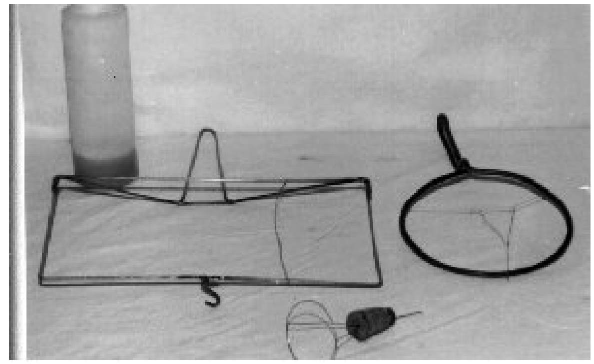
PIRA #:

Demonstration web pages at other schools

F30: Soap Bubble Films

Purpose: To demonstrate surface tension effects in liquids and in thin films of soap bubbles.

Description:



1. Rectangular loop. Immerse loop in soapy solution to form a film across the two sections. Poke out the film in one section, and notice that the cross-wire bends toward the remaining film. You can slide the cross-wire to form any desired relative size for the films.
2. Circular loop. Dip the loop into the solution to form a film across all sections. Poke out the center section of film, and notice that surface tension pulls the thread to form a circularly shaped hole.
3. Cork and loop. Show that the cork floats on the surface of clean water. With the handle provided, push the cork down into the water until the circular loop is just below the water surface and the cork is below the loop. Release the device and notice that surface tension keeps the loop and cork submerged.

   To show the action of detergents in reducing surface tension, drop in a few drops of liquid detergent while the cork and loop are submerged, and notice that the loop pops out of the water.
4. Carefully lay the flat piece of metal on the surface of a beaker of clean water. The surface tension will hold the metal on the surface. Pour in a few drops of liquid detergent. The detergent reduces the surface tension and the metal drops.
5. Make large bubbles with the device to the right.

Equipment List	**Storage Location (CHEMP 130A map)**
Soapy solution (e.g., a mixture containing equal parts of distilled water, glycerin, and liquid detergent)	**C4.4**
rectangular wire loop with thin moveable cross-wire, circular loop with threads tied across, thin wire loop attached to cork,	**C4.4**
beaker of clean water	**C4.4**
liquid detergent	**C4.4**
small flat piece of metal.	**C4.4**

References:

Manufacturer: VT, Sargent-Welch

Manual:

Teaching Suggestions: F30

Setup Notes: F30

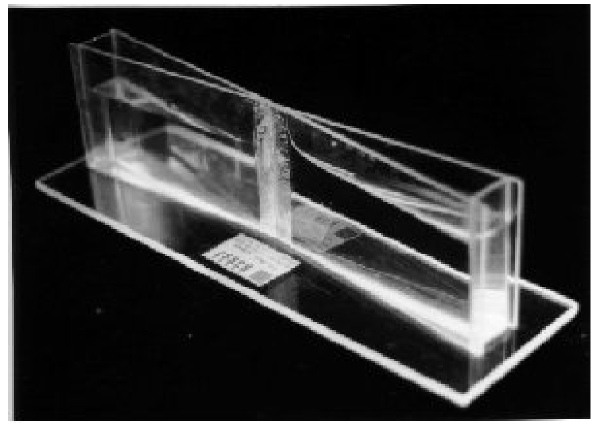
PIRA #:

Demonstration web pages at other schools

F34: Surface Tension

Purpose: To exhibit surface tension and capillarity effects

Description:



Cenco-Miller Surface Tension Demonstrator, colored water, mercury or other liquid in which cohesive forces between liquid molecules are greater than adhesive forces between liquid and glass molecules.

Pour water into one side and mercury into the other side of the demonstrator. Display the shape of the liquid surface in the sharp corners of the wedge-shaped sides. The water curves upward near the point and the mercury curves downward.

Equipment List

Cenco-Miller Surface Tension Demonstrator

Storage Location (CHEMP 130A map)

Currently not available

References:

Manufacturer:

Manual: online

Teaching Suggestions: F34

Setup Notes: F34

PIRA #:

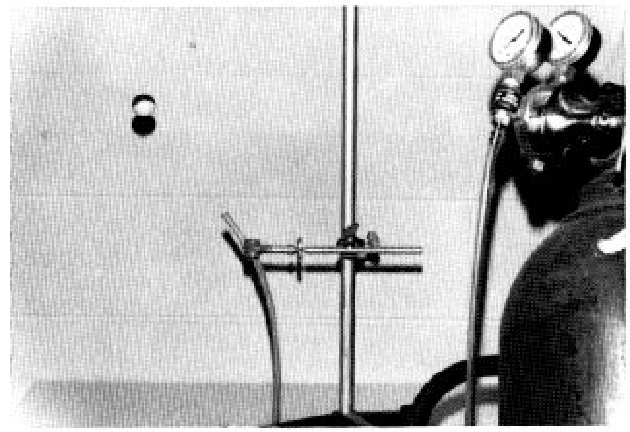
Demonstration web pages at other schools

F50: Bernoulli's Principle

Purpose: To show how a deflected jet of air will cause enough pressure difference to hold a ball suspended in midair.

Description:

Aim a jet of gas upward from the Pasco Air track blower. Place the Ping Pong ball or styrofoam ball in the jet and notice that it stays. The air jet may be tilted about 45^{o} and the ball will remain suspended.



This photo is soon to be updated!

Equipment List

Ping Pong ball, Styrofoam ball

Pasco Air track blower

Storage Location (CHEMP 130A map)

C5.3

Lecture table 2

References:

Manufacturer: VT

Manual: none

Teaching Suggestions: F50

Setup Notes: F50

PIRA #:

Demonstration web pages at other schools

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

F51: Pasco Bernoulli Cart

Purpose: To demonstrate the Bernoulli principle on a rotating cylinder.

Description:

This 5 cm diameter cylinder with precision ball bearings, easily set spinning by pulling a string, provides an excellent demonstration of the Bernoulli Principle. Requires a fan or air blower to provide airflow across the rotating cylinder.

Equipment List	Storage Location (CHEMP 130A map)
Pasco Bernoulli accersory mounted on Pasco Collision Cart	**D1**
Pasco Air track blower	**Lecture table 2**

References:

Manufacturer: Pasco Scientific # ME-9481, ME-9485

Manual: online

Teaching Suggestions: F51

Setup Notes: F51

PIRA #:

Demonstration web pages at other schools

F53: Venturi Meter Demonstration

Purpose: Convenient Kit for Illustrating Bernoulli's Law

Description:

The Venturi tube, which consists of a plain tube with a smooth constriction in its bore at the middle, is one of the most widespread applications of Bernoulli's Law. It is found in carburetors, fluid flow meters, and aircraft airspeed indicators, to name a few uses. This demonstration version is made of glass and has three side tubes for attaching an included three-leg manometer filled with colored water to show the relative pressures at significant points of the tube when gas is flowing through it. A sufficient flow of gas to produce clear differences of water level in the three manometer legs can be generated by blowing through the tube. The tube is 22cm long, 2.0cm in diameter at the wide ends, and narrows to 10cm in diameter in the middle. There is tubulation at each end for attaching 6.4mm diameter rubber tubes.

Equipment List

Venturi tube

Storage Location (CHEMP 130A map)

References:

Manufacturer: Sargent-Welch # CP31043-00

Manual: online

Teaching Suggestions: F53

Setup Notes: F53

PIRA #:

Demonstration web pages at other schools

F60: Acoustic Cannon

Purpose: To display some of the transport properties of gases.

Description:

The Air Cannon uses a vortex of air for ammunition. Its unique shape creates a stable toroidal vortex. Pull back the flexible membrane, release and the invisible wave front of air can hit a target 20 feet away! A great demonstration of the energy that can be stored in waves. Use a stage fogger to let the students see the vortex

1. Aim the cannon at a person several meters away; pull back the plastic cover and release it. The person will feel a puff of air after an appreciable delay.
2. Fill the cannon with fog. Fire it horizontally across the room. A fog ring will travel a great distance without dispersing.

Equipment List	**Storage Location (CHEMP 130A map)**
Acoustic Cannon	**D3.3**
Stage Fogger	**D3.3**

References:

Manufacturer: Pasco Scientific #

Manual:

Teaching Suggestions: F60

Setup Notes: F60

PIRA #:

Demonstration web pages at other schools

Heat & Thermodynamics

H01: Computer Based Thermometers

H02: Conventional Thermometers

H03: Liquid Crystal Sheets

H04: Molecular Models

H05: Molecular Motion

H10: Thermal Expansion of Air

H14: Thermal Expansion of Metals

H18: Ice Bomb

H20: Pressure vs. Temperature

H30: Low T Boiling of Water-Vacuum

H31: Low T Boiling of Water-Franklin Flask

H40: Thermal Conductivity

H44: Convection in Gases

H48: Radiometer

H55: Solar Cell

H56: Thermoelectric Converter

H57: Low delta T Sterling Engine

H70: Thermocouple Lifting Magnet

H90: Reverse Entropy Machine

H92: 3-D Triple point plot

H95: Drinking Bird

H96: Palm Glass

H01: Computer Based Thermometers

Purpose: To show the many way that temperture can be measured. To measure the temperature of various experiments.

Description:

CI-6605

This low thermal mass Temperature Sensor ensures a quick response and negligible impact on measured temperatures. This is a one-piece sensor that incorporates a stainless steel sensing element for durability. Comes with a Teflon cover for use in harsh liquids or chemical solutions.

The sensor consists of the stainless steel probe, a 3-foot cable and an 8-pin connector. Temperature can be measured in degrees Celsius, Fahrenheit, or Kelvin.

CI-6525

PASCO's resistance temperature device is a highly accurate Temperature Sensor made from platinum wire.
Typical Applications: Conduct experiments where temperature to within 0.5 °C is required. Measure temperatures down to -200 °C (liquid nitrogen)

Specifications: Temperature Range -200 °C to +200 °C , Accuracy less than 0.5 °C full scale, Resolution 0.2 °C

CI-6536

The High Temperature Type K Probe must be plugged into ScienceWorkshop the PASCO's Type K Temperature Sensor.

The High Temperature Type K Probe must be plugged into ScienceWorkshop the PASCO's Type K Temperature Sensor.

Equipment List	**Storage Location** (CHEMP 130A map)
CI-6605 Low thermal mass temperture sensor	**C5**
CI-6525 Platinum wire thermometer	**C5**
CI-6536 High Temperture type K thermometer	**C5**

References:

Manufacturer: Pasco Scientific # CI-6605 , CI-6525 , CI-6536

Manual: online

Teaching Suggestions: H01

Setup Notes: H01

PIRA #:

Demonstration web pages at other schools

H02: Conventional Thermometers

- **Purpose:** To show various way that temperture can be measured.
- **Description:** Alcohol and Mercury thermometers. A Bimetalic thermostat

- **Equipment List**

Storage Location (CHEMP 130A map)
C4

- **References:**

Manufacturer:
Teaching Suggestions: H02
PIRA #:
Manual: online
Setup Notes: H02
Demonstration web pages at other schools

H03: Liquid Crystal Sheets

Purpose: To demonstrate another physical property that is effected by temperture.

Description:

Two large sheets of liquid crystal material that change as the temperature changes. Placing a hand on the top of the sheet for 30 seconds cause a nice color change. The color is displayed well to the class by using the Document camera.

Equipment List **Storage Location** (CHEMP 130A map)

Liquid Crystal Sheets

References:

Manufacturer: Sargent-Welch # WLS-81416-A

Manual:

Teaching Suggestions: H03

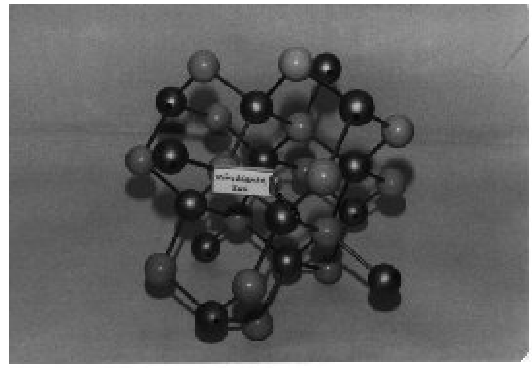
Setup Notes: H03

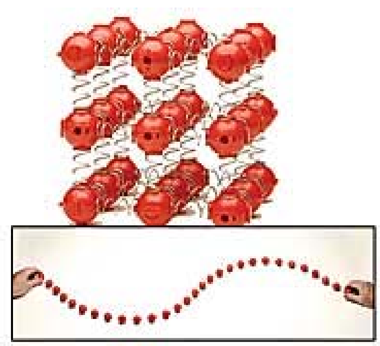
PIRA #:

Demonstration web pages at other schools

H04: Molecular Models

- **Purpose:** To illistrate the many types of crystaline structure that exist. To illistrate interatomic bonding and vibrations.
- **Description:** Models of crystals (several types available)





- **Equipment List**

Storage Location (CHEMP 130A map)
old demo area (Rob 206A)
C5.2

- **References:**

Manufacturer: Pasco Scientific # ME-9825
Manual: online
Teaching Suggestions: H04
Setup Notes: H04
PIRA #:
Demonstration web pages at other schools

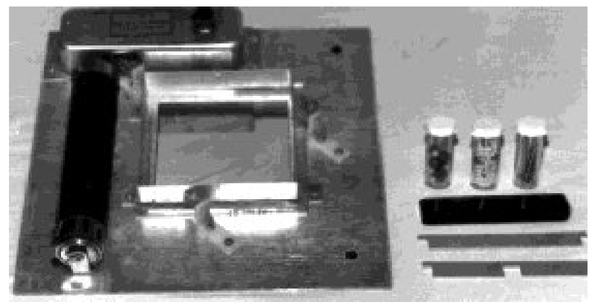
H05: Molecular Motion

Purpose: To demonstrate the kinetic theory of gases.

Description:

EME Molecular Motion Demonstrator, three D-sized batteries, wood support, aluminum strip with cutout (diffusion barrier), aluminum strip (solid barrier), black bar (piston), red disc (Brownian movement), balls of various sizes, overhead projector.

This demonstrator is to be displayed on the Cannon Document camera. Possible experiments to do are



1. Brownian Movement
2. Random Motion of Molecules in Gases
3. Gas Pressure
4. Temperature of a Gas
5. Diffusion
6. Avogadro's Hypothesis
7. Van der Waals Forces
8. Boyle's Law
9. Charles' Law
10. Solids and Liquids

These demonstrations are discussed in detail in the *EME Molecular Motion Demonstrator Study Guide.* (See the Teaching Suggestions link below.)

Equipment List

EME Molecular Motion Demonstrator

Storage Location (CHEMP 130A map)

C5.2

References:

Manufacturer: Sargent-Welch # WL1710M

Manual:

Teaching Suggestions: H05

Setup Notes: H05

PIRA #:

Demonstration web pages at other schools

H09: Galileo's Thermometer

Purpose: Demonstrate temperature and iIts effect on density

Description:

This classic thermometer ingeniously uses the expansion of liquids and floating spheroids to measure temperature. The density of each spheroid has been adjusted to correspond exactly with the density of the supporting liquid at the designated temperature. The six spheroids float at low temperatures and sink at temperatures ranging from 65° to 90° F in increments of 5°.

Warm the thermometer up before class and let the spheres drop as the water cools to room temperature. Can be used as a challenge question about how it works (see the teaching suggestions link below).

Equipment List

Galileo's Thermometer

Storage Location (CHEMP 130A map)

C4.6

References:

Manufacturer: Sargent-Welch # WLS81480

Manual: online

Teaching Suggestions: H09

Setup Notes: H09

PIRA #:

Demonstration web pages at other schools

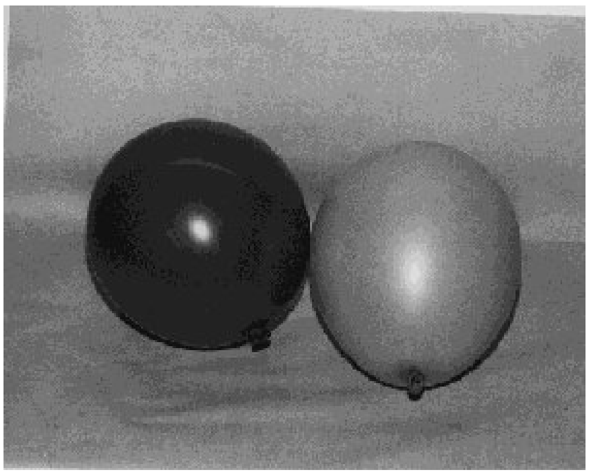
H10

Thermal Expansion of Air

Purpose: To show the expansion and contraction of air during large temperature changes.

Description: Inflate a balloon and place it in liquid nitrogen. Let it return to room temperature

Before cooling



After cooling

Equipment List

Balloons

liquid nitrogen dewars

Storage Location (CHEMP 130A map)

C4.3

F4.4

References:

Manufacturer:

Teaching Suggestions: H10

PIRA #:

Manual:

Setup Notes: H10

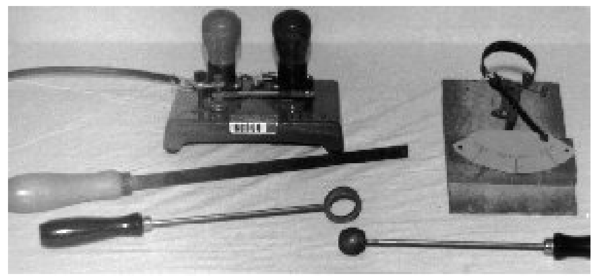
Demonstration web pages at other schools

H14: Thermal Expansion of Metals

Purpose: To show the thermal expansion of metals, and how this effect is used in bimetallic thermometers and thermostats.

Description:

1. Ball and ring. Ask the class whether the hole in the ring gets larger or smaller when heated. Show that the ball just fits through the ring. Heat the ball over the Bunsen burner until it will not go through the ring. While keeping the ball hot, heat the ring until the ball goes through.
2. Bimetallic strip. Heat the strip with the heat gun or Bunsen burner and show that it bends due to differential expansion.
3. Thermometer. Use the heat gun to heat the bimetallic strip of the thermometer and note the effect on the pointer.
4. Thermostat. Plug in the apparatus and note that one bulb burns. Using the heat gun, heat the bimetallic strip until the light goes off, thus showing the effect of a thermostat to regulate a heating system. Additional heating bends the strip downward to the lower contact, lighting the other bulb. This shows the effect of a thermostat used to control a cooling system. **CAUTION: THE BIMETALLIC STRIP CAN BE AT LINE VOLTAGE** if the plug is inserted into its receptacle backwards. Whichever way the plug is inserted, **SOME OF THE EXPOSED TERMINALS ARE AT LINE VOLTAGE.**



Equipment List	**Storage Location (CHEMP 130A map)**
Ball and ring on wooden handles	**C4.3**
bimetallic strip on a wooden handle	**C4.3**
model bimetallic thermometer	**C4.3**
demonstration thermostat	**C4.3**
heat gun, Bunsen burner	**C4.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: H14

Setup Notes: H14

PIRA #:

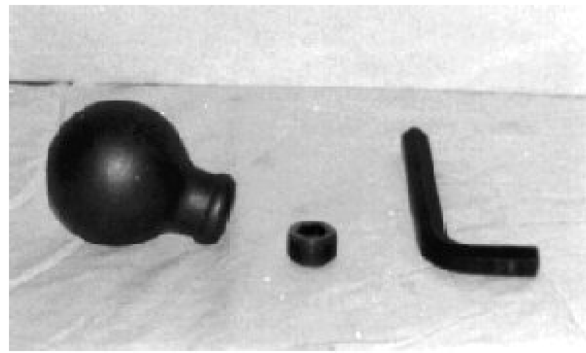
Demonstration web pages at other schools

H18: Ice Bomb

Purpose: To show dramatically the effect of the expansion of water as it freezes.

Description:

Completely fill the ice bomb with water and screw the cap on tightly. Completely surround the bomb with dry ice and place the wire cage over the assembly. Go on with your lecture. In 5 to 10 minutes -- long enough for the class to have lost interest in watching it -- the bomb will explode with a loud bang. Note: Anyone within about 2 meters of the explosion might be sprayed with water. The screen should stop any flying pieces of bomb.



You might want to take advantage of the dry ice lying around, by dropping a piece of it into a beaker of water and asking the class to explain what the mist is that rolls out. (Water vapor droplets condensed from the air by the cold gas.)

Equipment List

Ice bomb, wrench, water, dry ice

wire cage

Storage Location (CHEMP 130A map)

C5.6

References:

Manufacturer:

Manual: online

Teaching Suggestions: H18

Setup Notes: H18

PIRA #:

Demonstration web pages at other schools

H20: Pressure vs. Temperature

Purpose:

Description:

Your students can find the relationship between temperature and pressure for a variety of gases using this apparatus. Simply designed and sturdily made, it has a metal bulb to hold gas and a Bourdon gauge to indicate pressure. There is a valve near the gauge for letting gas in and out. Just fill the apparatus with gas, then heat or chill the bulb to different temperatures. The gauge will indicate the pressure at a given temperature. Students can graph the results to understand this important relationship and estimate the absolute zero temperature. Apparatus is 55cm long, bulb is 10cm in diameter.

Equipment List

Storage Location (CHEMP 130A map)

C4.2

C4.5

C4.3

References:

Manufacturer: Sargent-Welch # CP76408-00

Teaching Suggestions: H20

PIRA #:

Manual:

Setup Notes: H20

Demonstration web pages at other schools

H30: Low Temperture Boiling of Water-Vacuum Pump

Purpose: To show that water will boil at room temperature if the pressure is reduced enough.

Description:

A. Invite a student to sample the temperature of the water in the beaker by inserting a finger into it. Place the beaker into the bell jar and evacuate. After the water has boiled briefly, ask students to predict the water temperature. Let air into the jar, remove the water, and let the student sample the temperature.

Equipment List

bell jar

Beaker of water

vacuum pump.

Storage Location (CHEMP 130A map)

E3.3

I1

moble lecture table

References:

Manufacturer:

Manual:

Teaching Suggestions: H30

Setup Notes: H30

PIRA #:

Demonstration web pages at other schools

H31:Low Temperature Boiling of Water-Franklin flask

Purpose: To show that water will boil at room temperature if the pressure is reduced enough.

Description:

Initially, this specially designed 1-liter flask should be in a normal upright position and partially filled with water. After bringing the water to a boil, close off the neck with a rubber stopper fitted with a thermometer and invert the flask. Place ice in the special concave bottom. As you do so, the water starts boiling rapidly again. The thermometer clearly shows the temperature is falling, but the water will boil until it is only 15° or 20° above room temperature. Includes rubber stopper with hole and thermometer. Requires Iron Support Ring with Clamp, approx. 12cm I.D., not included. Fill the Franklin flask about one-third full of water, and boil it to remove the dissolved air. Remove the heat source and insert the stopper with a thermometer through it. Invert the flask and put ice in the indentation in the flask.

Equipment List	Storage Location (CHEMP 130A map)
Franklin flask on ring stand	**C4.2**
Bunsen burner	**C4.5**
thermometer	**C4.3**

References:

Manufacturer: Sargent-Welch # CP77775-00

Manual: online

Teaching Suggestions: H31

Setup Notes: H31

PIRA #:

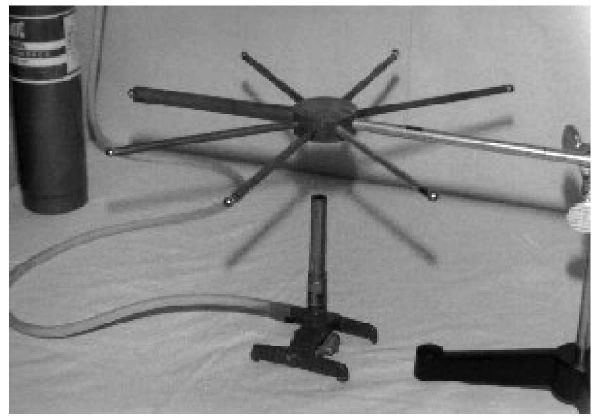
Demonstration web pages at other schools

H40: Thermal Conductivity

Purpose: To illustrate the relative thermal conductivity of different materials and also how conduction is affected by the cross-sectional area.

Description:

A hub with six rods of different materials of the same diameter and length (nickel, nickel-silver, iron, copper, brass, aluminum) and an iron rod twice the diameter of the other, stand with clamps, Bunsen burner, wax, and seven steel balls.



Attach the steel balls to the end of each bar of metal with a small piece of wax. Then heat the center hub with a Bunsen burner. The relative conductivity is illustrated by the relative times required for the wax to melt and the ball to drop from each rod. As explained in detail in the manufacturer's instructions, to account for the difference in time for the iron rods of different diameters, you must consider not only the larger cross-sectional area but also the larger surface area that dissipates heat to the surroundings.

Equipment List	**Storage Location** (CHEMP 130A map)
A hub with six rods of different materials	**C4.3**
propane burner	**C4.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: H40

Setup Notes: H40

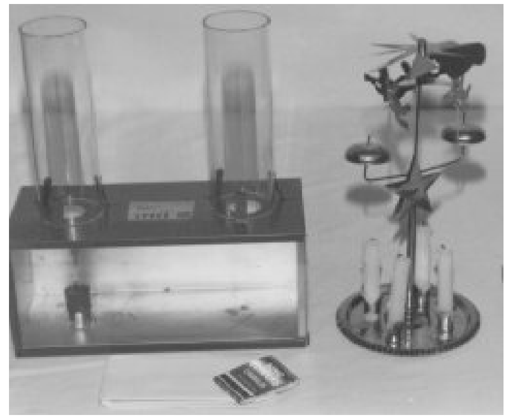
PIRA #:

Demonstration web pages at other schools

H44: Convection in Gases

Purpose: To illustrate convection in gases.

Description:



1. Dual chimney system. Light the candle inside the box and close the glass cover. Light a piece of touch paper and hold it near the top of the chimney that has no candle beneath it. Smoke will be forced down that chimney and up the one above the candle.
2. Angel Chimes. This dining-table centerpiece operates by convection and gives a tinkling sound while operating. Note: Even a slight air movement through the room will prevent proper operation.

Equipment List	**Storage Location (CHEMP 130A map)**
Cenco dual chimney system	**C4.4**
touchpaper	**C4.4**
"Angel Chimes."	**C4.4**

References:

Manufacturer:

Manual: online

Teaching Suggestions: H44

Setup Notes: H44

PIRA #:

Demonstration web pages at other schools

H48: Radiometer

Purpose: To illustrate increased absorption of radiation by dark-colored objects, and the expansion of heated gases.

Description:

Expose the radiometer to sunlight or other bright light. The darker sides of the propeller absorb more radiation, thus heating the adjacent air more effectively. The expansion of the air near the darker sides causes the propeller to turn.

Equipment List	**Storage Location (CHEMP 130A map)**
Radiometer	**C3.3**
flood lamp	**C3.3**

References:

Manufacturer:

Manual: online

Teaching Suggestions: H44

Setup Notes: H44

PIRA #:

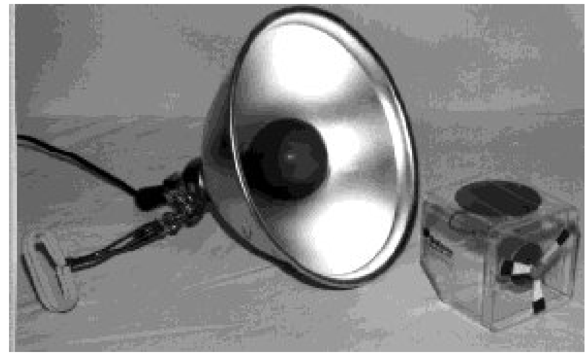
Demonstration web pages at other schools

H55: Solar Cell

Purpose: To show that radiant energy can be converted to electrical energy, which can then do mechanical work.

Description:

Shine the light on the solar cells and watch the propeller turn. For an added thrill, you can focus the light by using a large lens or concave mirror, and show that you get significant radiation hitting the cell only when the system is properly focused.



Equipment List

Solar cell connected to a motor attached to a propeller, bright light source.

Storage Location (CHEMP 130A map)

C3.3

References:

Manufacturer:

Manual:

Teaching Suggestions: H55

Setup Notes: H55

PIRA #:

Demonstration web pages at other schools

H56: Thermoelectric Converter

Purpose: Demonstrates the Second Law of Thermodynamics. Demonstrates that thethermodynamics are reversible.

Description:

Heat to Electrical Energy:

Place one leg of the Thermoelectric Converter into cold water, the other into hot. The fan turns as the converter draws energy from the hot source (typically a 50°C temperature differential is required).

Electrical Energy to Heat:

Pass a current (3 A DC at 5 V) through the Thermoelectric Converter. It acts as a "heat pump." One leg becomes warmer while the other becomes cooler.

Equipment List

Thermoelectric Converter

Styrofoam cups

hot and cold water, dry ice, or liquid nitrogen to maintain a temperature difference

Storage Location **(CHEMP 130A map)**

C5.3

References:

Manufacturer: Pasco Scientific # TD-8550A

Manual: online

Teaching Suggestions: H56

Setup Notes: H56

PIRA #:

Demonstration web pages at other schools

H57: Low delta T Sterling Engine

Purpose:

Description:

The Stirling Engine runs on the heat from a warm hand (approximately a 4° C differential from room temperature). This beautifully made engine featuring high precision components, low-friction graphite piston, ball bearings and counter-weighted cranks will amaze students. When it's not used in class, teachers can set it on the back of their computer monitor and explain thermodynamics to students who come into their office.

Equipment List

Low delta T Sterling Engine

Storage Location (CHEMP 130A map)

C5

References:

Manufacturer: Pasco Scientific # SE-8576A

Teaching Suggestions: H57

PIRA #:

Manual:

Setup Notes: H57

Demonstration web pages at other schools

H58: Pasco Heat Engine

Purpose: To demonstrate the carnot heat engine cycle. To show the P-V relationship in a heat engine.

Description:

- Heat Engine Efficiency
- Isothermal Processes
- Isobaric Processes
- Ideal Gas Law

A P-V diagram is generated as a heat engine is taken through a cycle. From this diagram, the heat added to the gas and the work done by the engine are measured to determine the efficiency of the engine. This actual efficiency is compared to the theoretical maximum efficiency.

This heat engine consists of air inside a cylinder which expands when the attached can is immersed in hot water. The expanding air pushes on a piston and does work by lifting a weight. The heat engine cycle is completed by immersing the can in cold water, which returns the air pressure and volume to the starting values.

The cycle is performed as follows:

1. With the can in the cold bath, the 200 g mass is placed on the platform.
2. The can is moved from the cold bath to the hot bath.
3. The 200 g mass is removed from the platform.
4. The can is moved from the hot bath to the cold bath.

The change in pressure is measured with a Low Pressure Sensor. The change in piston height is measured by the attached string over the Rotary Motion Sensor pulley. The change in volume is calculated by multiplying the change in piston height by the piston cross-sectional area.

Equipment List

Storage Location (CHEMP 130A map)

Heat Engine/Gas Law Apparatus (TD-8572)

Rotary Motion Sensor (CI-6538)

Temperature Sensor (CI-6605)

Low Pressure Sensor (CI-6534A)

Support rod and stand.

Hot and cold temperature baths.

References:

Manufacturer: Pasco Scientific EX-9911

Manual: online

Teaching Suggestions: H58

Setup Notes: H58

PIRA #:

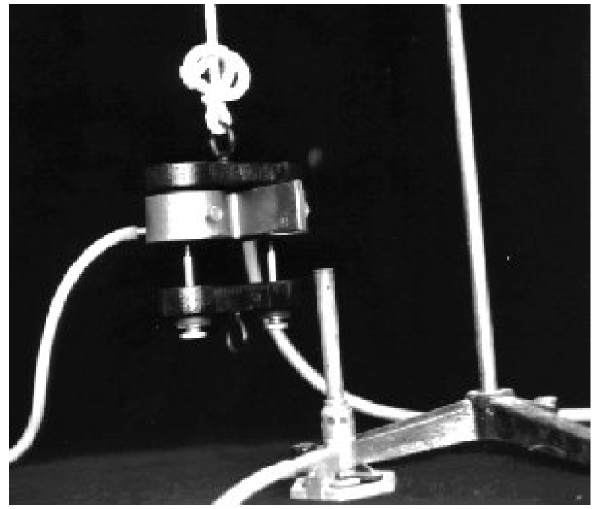
Demonstration web pages at other schools

H70: Thermocouple Lifting Magnet

Purpose: To show that currents produced by a temperature gradient are large enough to produce a strong magnet.

Description:

Hang the thermocouple magnet from a good support. Hook the intake spout to a faucet and run cool water through the coil. Then, while heating the coil bar, move the armature up from the bumpers, making sure that it makes good contact with the coil. Now you may attach more weights to the hook (up to 900 N) as the bar gets hotter. (For more information, see the instructions with thermocouple lifting magnet.)



Equipment List	Storage Location (CHEMP 130A map)
thermocouple magnet	**C4.3**
rope, weights and hanger	**C4.3**
propane burner	**C4.3**
Cold water supply	

References:

Manufacturer:

Manual:

Teaching Suggestions: H70

Setup Notes: H70

PIRA #:

Demonstration web pages at other schools

H90: Reverse Entropy Machine

Purpose: To show a reversible transformation.

Description:

Insert the pipette filled with red dye into the glycerin and leave a long red line. Turn the smaller cylinder slowly, being careful not to cause any turbulence. After the dye has been sufficiently smeared, reverse and rotate the same number of turns. The dye is brought back into a line.

Equipment List	**Storage Location (CHEMP 130A map)**
Reverse entropy machine	**C5.3**
glycerin, red dye, glass pipette	**C5.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: H90

Setup Notes: H90

PIRA #:

Demonstration web pages at other schools

H92: 3-D Triple Point Plot

- **Purpose:** To show the phase relationship of water at various pressures, temperatures, and volumes.
- **Description:**

The plot can be displayed to the class using the Cannon Document Camera

- **Equipment List**

3-D Triple Point Plot

Storage Location (CHEMP 130A map)

C4.1

- **References:**

Manufacturer:

Manual:

Teaching Suggestions: H92

Setup Notes: H92

PIRA #:

Demonstration web pages at other schools

H95: Drinking Bird

Purpose: To demonstrate that a difference in temperature will create a difference in vapor pressure. It is also a fun novelty.

Description:

Simply moisten the bird's head with water, place it next to a full glass of water and watch as the bird periodically dunks its head into the glass for a "drink." The bird's head is covered with a material that absorbs water, ensuring that its head remains cooler than its body. The difference in temperature between the head and body creates a vapor pressure differential within the bird which causes the liquid to rise in the neck. When the liquid enters the head, it causes the bird to tip over into the water for another drink.

Equipment List	Storage Location (CHEMP 130A map)
Drinking Bird	C4.4
cup for water	C4.4

References:

Manufacturer: Pasco Scientific # SE-7570

Manual: online

Teaching Suggestions: H95

Setup Notes: H95

PIRA #:

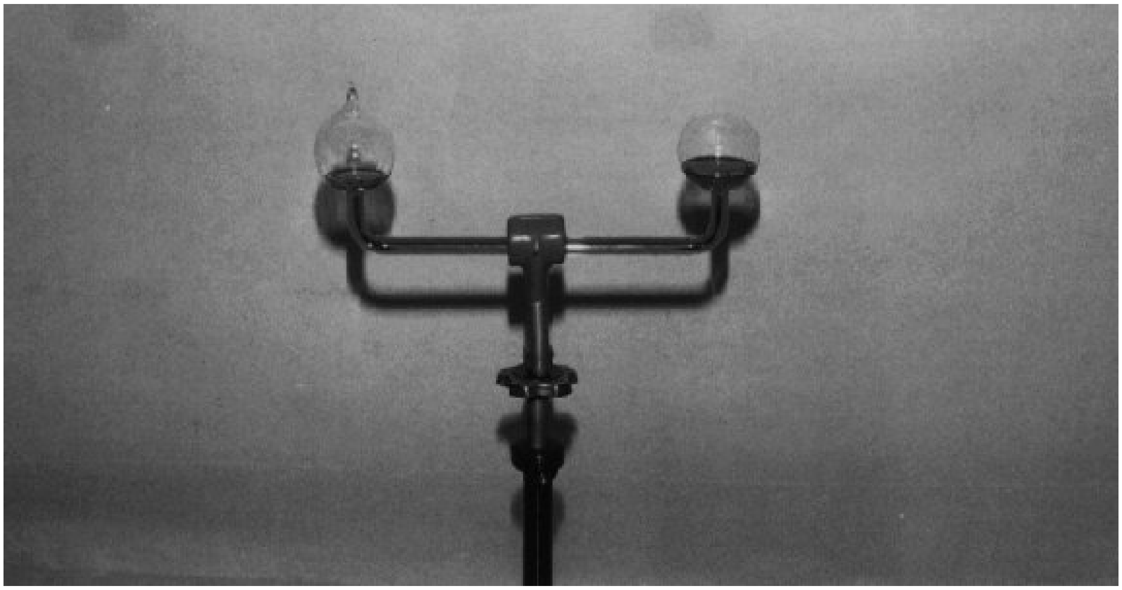
Demonstration web pages at other schools

H96: Palm Glass

Purpose: To demonstrate that a difference in temperature will create a difference in vapor pressure.

Description:

Grip one of the bulbs. The heat from your hand will cause the liquid in the glass to move to the other bulb.



Equipment List

Palm glass

Storage Location (CHEMP 130A map)

C4.2

References:

Manufacturer:

Teaching Suggestions: H96

PIRA #:

Manual:

Setup Notes: H96

Demonstration web pages at other schools

Electricity & Magnetism

Electricity & Magnetism

E56: Force between Parallel Currents

E60: Solenoid in a Magnetic Field

E63: Faraday's Law I

E64: Faraday's Law II

E66: Self-Inductance

E67: Pasco Lenz's Law Demonstrator

E68: Induced Currents-Jumping Rings

E72: Lenz's Law Pendulum

E74: LR and LRC Circuits

E75: RC Circuits

E76: LR and LRC Circuits with AC

E80: Wooden Motor Model

E81: Working Motor/Generator Model

E82: Hand Crank Motor/Generators

E85: Tesla Coils

E86: Plasma Ball

E87: Jacobs Ladder

E89: Superconductivity

E90: Electrical Analog Meters

E91: Electrical Digital Meters

E92: Electrical Signal Generators

E93: Electrical Power Supplies

E94: Digital Oscilloscope

E01:Electrostatic Interactions

Purpose: to show the basic interactions of charged objects such as attraction and replusion. Also show how a simple electroscope can be use to measure electric charge.

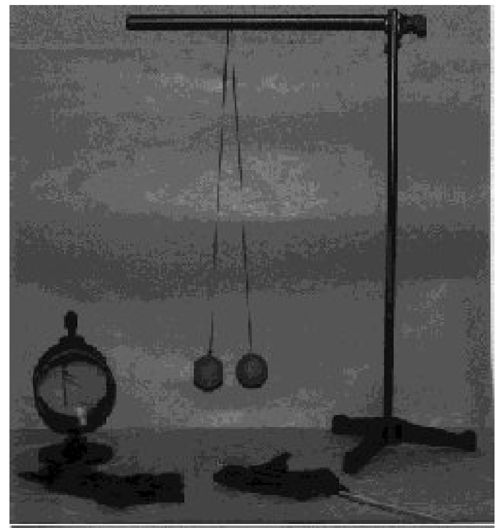
Description: Rub the plastic rod with fur to charge the rod negatively. Rub the glass rod with silk to charge the rod positively.

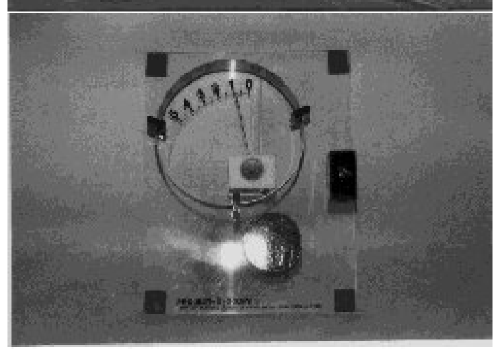
Show that nuetral objects are attracted to a charged rod. Small bits of paper work well for this.

Place a charged rod in the cradle and show that like rods repel and different rods attract.

Use the rods to charge the Styrofoam balls and show their attraction and repulsion.

Use the rods to charge the electroscope to demonstrate a method for measuring electric charge. The projection electroscope can be placed on the Cannon Document camera for easy class viewing.





Equipment List	**Storage Location (CHEMP 130A map)**
Rubber rods and fur, glass rods and silk, other materials for producing charge by rubbing are also available. A cradle to hold the charged rods.	**C2.4**
Styrofoam balls coated with conductive paint hanging from a stand	**C2.4**
Projection electroscope	**C2.4**

References:

Manufacturer: VT, others unknown

Manual:

Teaching Suggestions: E01

Setup Notes: E01

PIRA #:

Demonstration web pages at other schools

E02:Properties of Electric Charge

- **Purpose:** To demonstrate qualitatively and quantitaively electrostatic effects
- **Description:**

Show that the electrometer gives the same sign of charge as defined by Franklin by placing charged rods onto the Faraday Ice Pail.

Show the equal and opposite charges are produced with the charge producers.

Equipment List	Storage Location (CHEMP 130A map)
Electrometer with cables, Faraday Ice Pail	**C2.2**
Charge Producers	**C2.2**

- **References:**

Manufacturer: Pasco Scientific # **ES-9080**

Manual: **online**

Teaching Suggestions for: E02

Setup Notes for: E02

PIRA #:

Demonstration web pages at other schools

E03:Distributions of Electric Charge

Purpose: To demonstrate qualitatively and quantitaively electrostatic effects

Description:

Show that the charge is uniformly distributed on a conductive sphere but not on an irregularly shaped conductive object.

Show how charges can be shared between two conductive spheres.

Show how charge can be transfered by an conductor but not by an insulator that connects two conductive spheres.

Equipment List	**Storage Location (CHEMP 130A map)**
Electrostatic voltage source with cables	**C2.2**
Electrometer with cables, Faraday Ice Pail	**C2.2**
2-Conductive spheres, Charge Producers, Proof plane	**C2.2**
Irregular shaped metal object on insulting stand	**C2.2**

References:

Manufacturer: Pasco Scientific # ES-9080

Manual: online

Teaching Suggestions for: E03

Setup Notes for: E03

PIRA #:

Demonstration web pages at other schools

E06:Capacitor-Commercial

Purpose: To familiarize students to the variety of capacitors that are commercially available

Description:

A board with a variety of commercially available capacitors. Place the board on the Cannon Document Camera for easy classroom viewing.

Equipment List

Capacitor board

Storage Location (CHEMP 130A map)

C2.3

References:

Manufacturer: various

Teaching Suggestions: none

PIRA #: none

Manual: none

Setup Notes: Place on Cannon document camera

Demonstration web pages at other schools

E10:Van de Graaff Generator

Purpose: To demonstrate high-voltage electrostatic phenomena.

Description:

Van de Graaff generator (VdG) and auxiliary dome, sharp-pointed rod ("magic wand").

Equipment List	**Storage Location (CHEMP 130A map)**
Van de Graaff generator	**B1.5**
auxiliary dome	**B1.5**
sharp-pointed rod ("magic wand").	**B1.5**

References:

Manufacturer:

Manual:

Teaching Suggestions: E10

Setup Notes: E10

PIRA #:

Demonstration web pages at other schools

E11:Wimshurst Machine

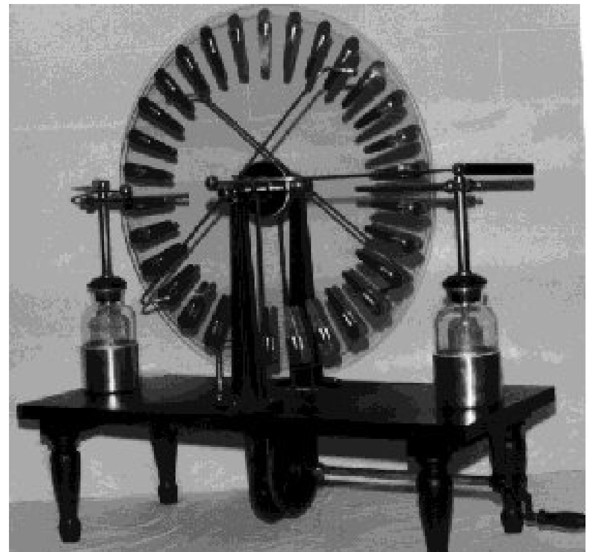
Purpose: To demonstrate high-voltage electrostatic phenomena.

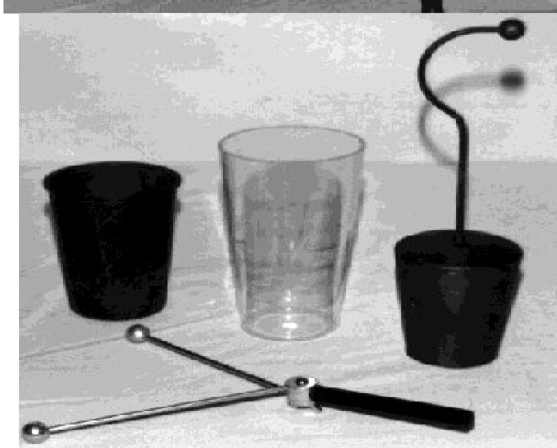
Description: Wimshurst machine, Leyden jar.

Use your own imagination, but some of the possible demonstrations are as follows:

1. Demonstrate arcing across several centimeters, indicating a potential difference of the order of 100 kV.
2. Charge the Leyden jar, and discharge it to produce a large spark. Recharge the Leyden jar; give each can to a separate student to hold; then reassemble and show that you still get an arc between the inner and outer cans. (The charge stays on the glass).

Note: Instructions are available for use of the Wimshurst Machine.





Equipment List	**Storage Location (CHEMP 130A map)**
Wimshurst Machine	**F3.4**
Dissectible Leyden jar.	**C2.4**
Discharge rod	**C2.4**

References:

Manufacturer:

Manual:

Teaching Suggestions: E11

Setup Notes: E11

PIRA #:

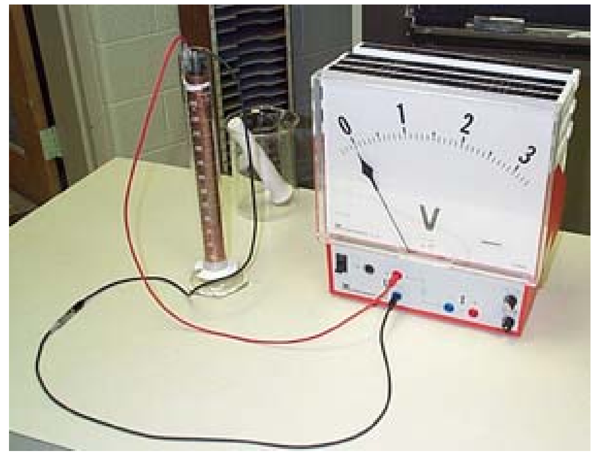
Demonstration web pages at other schools

E12:Simple Battery

Purpose: To show how easy it is to make a battery, to show the conversion of chemical to electrical energy, and to show that such a device could have been built by humans when they entered the iron age and began to grow grapes.

Description:

"Battery" consisting of a solid iron rod surrounded by a copper cylinder inside a glass cylinder; a voltmeter connected between the iron rod and copper cylinder; grapes (provided by demonstrator) and masher.



Mash grapes with masher to produce liquid. Humorous comments while doing so help generate interest. Pour liquid into beaker containing Fe and Cu cylinders. Voltmeter will show a potential difference of ~0.5 Volts.

Equipment List	Storage Location (CHEMP 130A map)
Analog Meter	**B1.3**
Battery	**C3.3**
Masher	**C3.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: E12

Setup Notes: E12

PIRA #:

Demonstration web pages at other schools

E13:Two Potato Clock

- **Purpose:** To show that two disimilar metals in an electrolite can produce an electric potential
- **Description:** Learn About the Galvanic Energy in Vegetables, Fruits and More

Insert the zinc and copper bimetallic probes of this electric clock into potatoes (or apples, cucumbers-even salt water or soda pop) and watch as the digital readout comes alive. Hours, minutes, seconds and date are resettable on the clock's red plastic base.

Works without vegtables using simple tap water. Instructor provide his/her own potatos if desired

Specify in the comment box if you want to use the close-up camera to display the clock.

- **Equipment List**

Two Potato Clock with electrodes

Storage Location (CHEMP 130A map)

C3.4

- **References:**

Manufacturer:

Manual:

Teaching Suggestions: E13

Setup Notes: E13

PIRA #:

Demonstration web pages at other schools

E15:Precipitation of Smoke by an Electric Field

Purpose: To demonstrate the effect of an electric field on charged particles.

Description:

Incense (to produce smoke), glass cylinder with metal top and bottom, light, video camera, high voltage power supply, metal ring containing electrodes.

The smoke filled cylinder (with electrode ring placed on the bottom) is illuminated and viewed with the close-up video camera. When 15 kV is applied, the smoke is seen to disappear, thus demonstrating the attraction of the (charged) smoke particles to the charged electrodes.

Equipment List

Storage Location (CHEMP 130A map)

This demonstartion is not currently available. A new version is being developed

References:

Manufacturer:

Manual:

Teaching Suggestions: E15

Setup Notes: E15

PIRA #:

Demonstration web pages at other schools

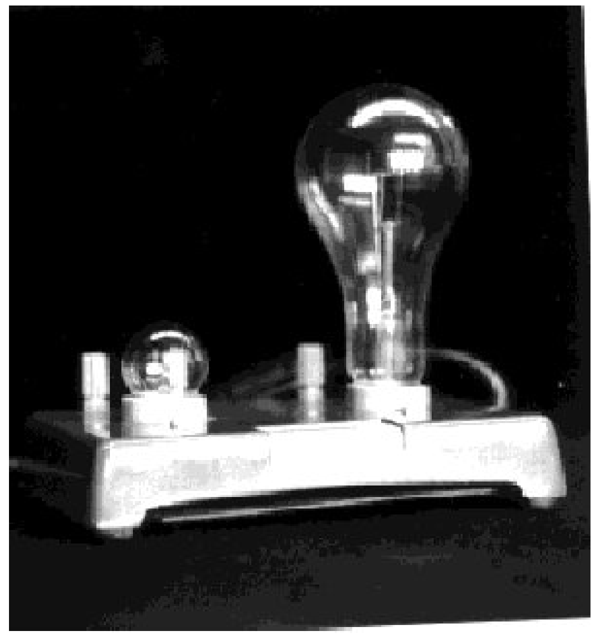
E18:Lamps in Series

Purpose: To show that the power dissipated by an incandescent lamp in a series circuit is inversely proportional to its power rating.

Description:

100W and 15W bulbs connected in series.

Plug in the system and remove a bulb to show that the two bulbs are in series. Replace the bulb and note that the 15W bulb is the one that emits the light. Terminals are provided for measuring voltage drops if quantitative measurements and calculations are desired.



Equipment List

100W and 15W bulbs connected in series.

Storage Location (CHEMP 130A map)

B1.1

References:

Manufacturer:

Manual:

Teaching Suggestions: E18

Setup Notes: E18

PIRA #:

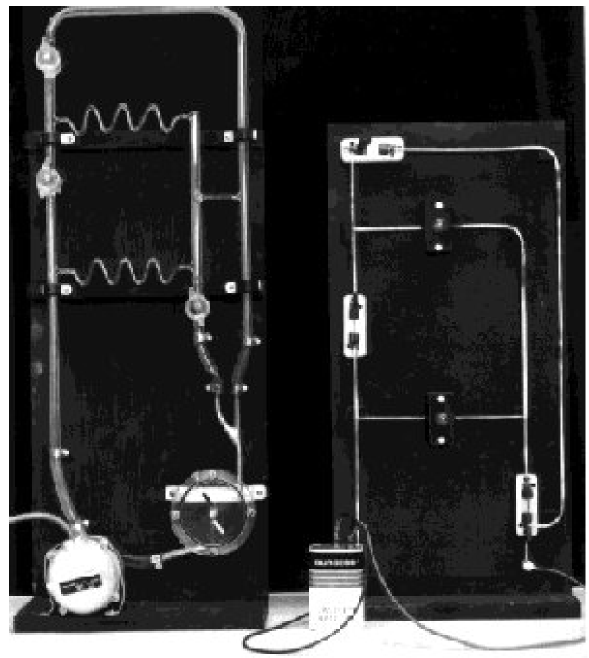
Demonstration web pages at other schools

E20:Series/Parallel Circuit Demonstration

Purpose: To compare series and parallel electrical circuits with series and parallel water circuits.

Description:

1. Electrical circuitry consisting of 2 light bulbs, a battery, and knife switches arranged so that the bulbs can be operated individually, in series, or in parallel; demonstration voltmeter and ammeter.
2. Water circuit consisting of circulating pump, stopcocks, two small wiggly sections of tubing (resistances), and a paddlewheel, arranged so that the resistances can be connected individually, in series, or in parallel; a stopwatch.



Connect the voltmeter and ammeter for measuring the voltage across, and the current to, the input of the electrical circuit. For both the electrical and the water circuits, compare the currents with one resistance, with two resistances in series, and with two in parallel. You can determine the current in the water circuit by counting the revolutions on the paddlewheel for a fixed time interval. Of course, the electrical current with two bulbs in series will not be one-half that with one bulb, because of the nonlinearity of the filament resistance as the filament temperature changes. This nonlinearity provides an opportunity to discuss its cause.

Equipment List

This demonstartion is not currently available. A new version is being developed

Storage Location (CHEMP 130A map)

F3

References:

Manufacturer:

Manual:

Teaching Suggestions: E20

Setup Notes: E20

PIRA #:

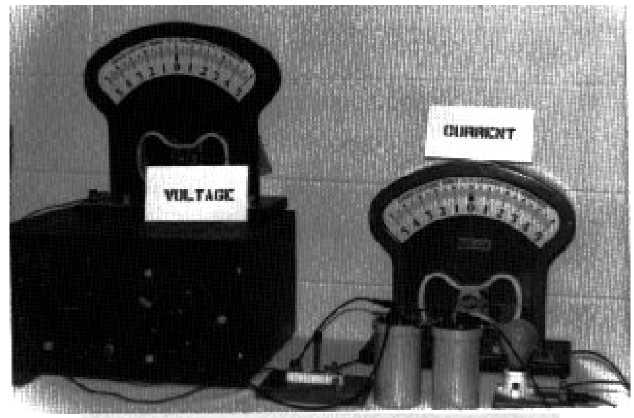
Demonstration web pages at other schools

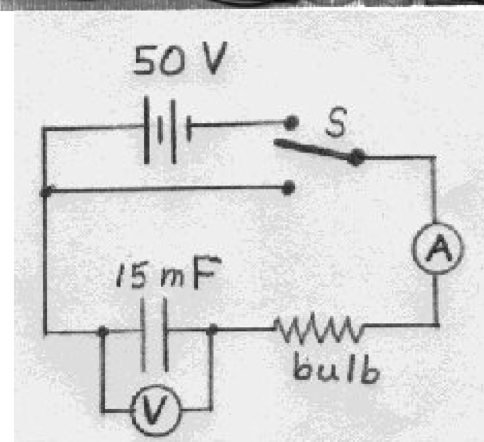
E23:RC Circuit

- **Purpose:** To show the charging and discharging of a capacitor in an RC circuit.
- **Description: A computer based version of this demonstation is under development**

DC power supply, 2 7.5-mF capacitors connected in parallel, voltmeter, ammeter, SPDT switch, light bulbs of 40- to 150-W power rating.

Connect the circuit as shown in the diagram. Move the switch to charge and discharge the capacitor, noting the variation in current, voltage, and lighting of the bulb. Vary the resistance by using bulbs of different power ratings.





Equipment List	Storage Location (CHEMP 130A map)
Analog Voltmeter	**B1.3**
Analog Ammeter	**B1.3**
Capacitor bank	**B1.3**
Light bulb in base	**B1.3**
DC power supply	**E4.3**

- **References:**

Manufacturer:

Manual:

Teaching Suggestions: E23

Setup Notes: E23

PIRA #:

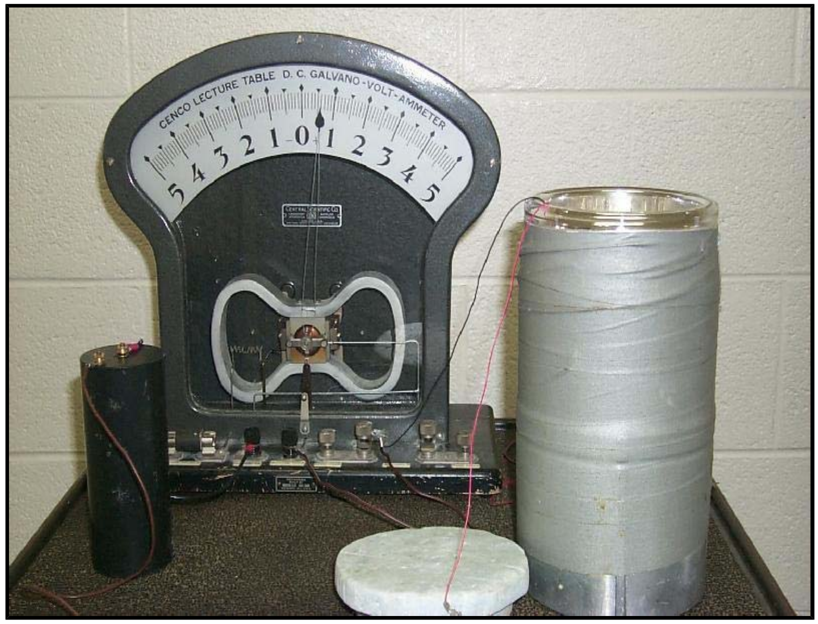
Demonstration web pages at other schools

E25:Resistance vs Temperature

Purpose: To demonstrate resistance as a function of temperature.

Description:

Hook up a circuit as in Fig. A and dip the thermistor in liquid nitrogen. For the circuit shown in Fig. B, dip the coil in liquid nitrogen. Note the variation of the current in each case.



Equipment List	**Storage Location (CHEMP 130A map)**
Analog galvanometer	**B1.1**
1.5-V battery, 22-ohm resistor, coil of copper wire with resistance several hundred ohms, thermistor	**B5.1**
liquid nitrogen dewar	**E4.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: E25

Setup Notes: E25

PIRA #:

Demonstration web pages at other schools

E38:Lodestone

- **Purpose:** To show a natually occuring magnet
- **Description:** Small samples of the mineral Magnitite

Place the lodestone on the Cannon Document camera for better class viewing.

- **Equipment List**

Lodestone samples

Storage Location (CHEMP 130A map)

B5.3

- **References:**

Manufacturer: Sargent-Welch # WLS44370

Manual:

Teaching Suggestions: E38

Setup Notes: E38

PIRA #:

Demonstration web pages at other schools

E39:Magnetic Compasses

Purpose: To show various properties of the earth's magnetic field. To show the meaning of the direction of a magnetic field. To illistrate the magnetic field around current carrying wires.

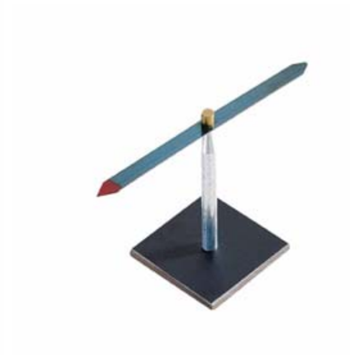
Description:

Transparent compass with angle measurements

Compass on stand

Magnetic Dip compass

Use the Cannon Document camera or Close-up Camera to improve the viewing for the class.



Equipment List	**Storage Location (CHEMP 130A map)**
Transparent compass with angle measurements	**B5.2**
Compass on stand	**B5.2**
Magnetic Dip compass	**B5.2**

References:

Manufacturer: Sargent-Welch

Manual: none

Teaching Suggestions: E39

Setup Notes: E39

PIRA #:

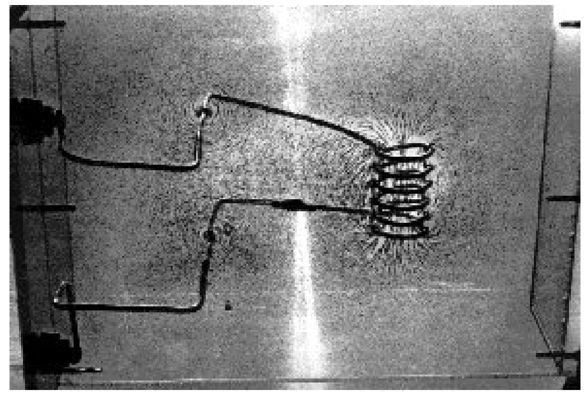
Demonstration web pages at other schools

E40:Magnetic Field Lines

Purpose: To demonstrate the magnetic field lines that surround a current carrying conductor and a solenoid.

Description:

It consists of a coilboard pierced by a solenoid and the two current carrying wires leading to it. A low voltage high current D.C. power supply provides the source of current (e.g., car battery).



Place the board on the Cannon Document camera. Turn on the power supply. Sprinkle iron filings on the board. Gently tap the board with a pencil until the filing align with the magnetic field. **Caution: Do not leave the power supply on for extended periods of time since the current is very large and thing really heat up.**

Equipment List	**Storage Location (CHEMP 130A map)**
Coil board	**B5.3**
Iron filings	**B5.3**
High cuurent DC power supply	**B6**

References:

Manufacturer: VT

Manual: none

Teaching Suggestions: E40

Setup Notes: E40

PIRA #:

Demonstration web pages at other schools

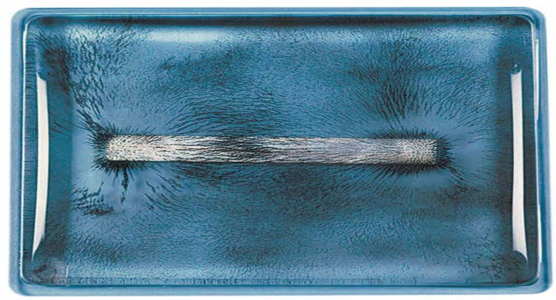
E41: 2-D Magnetic Field Demonstrator

Purpose: To show the magnetic field lines around a magnet.

Description:

Place a bar magnet or horse shoe magnet under the 2-D Magnetic Field Demonstrator. The iron filing will align with the magnetic field.

Place the 2-D Magnetic Field Demonstrator on the Cannon Document camera for better class viewing.



Equipment List	Storage Location (CHEMP 130A map)
2-D Magnetic Field Demonstrator	**B5.3**
Alnico bar magnet	**B5.3**
horse shoe magnet	**B5.3**

References:

Manufacturer: Sargent-Welch # CP30113-00

Manual: none

Teaching Suggestions: E41

Setup Notes: E41

PIRA #:

Demonstration web pages at other schools

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

E42: 3-D Magnetic Field Demonstrator

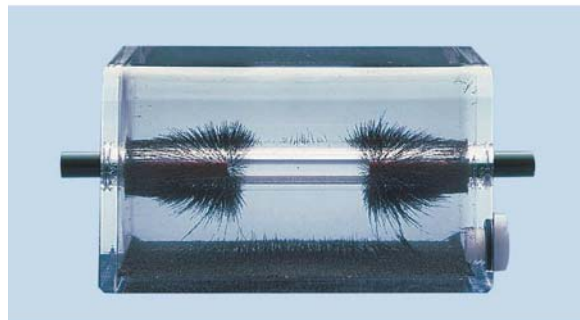
Purpose: To show the magnetic field lines around a magnet.

Description:

Option 1: Place a cylindrical bar magnet in the center of the 3-D Magnetic Field Demonstrator. The iron filing will align with the magnetic field.

Option 2: A current carrying wire can also be passed thorugh the hole in the center of the 3-D Magnetic Field Demonstrator to show the magnetic field around the wire.

Place the 3-D Magnetic Field Demonstrator on the Cannon Document camera for better class viewing.



Equipment List	**Storage Location (CHEMP 130A map)**
3-D Magnetic Field Demonstrator	**B5.3**
Cylindrical magnet(s)	**B5.3**

References:

Manufacturer: Sargent-Welch # CP31946-00

Manual:

Teaching Suggestions: E42

Setup Notes: E42

PIRA #:

Demonstration web pages at other schools

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

E43: Permanent & Electromagnets

Purpose: To show different types of magnets.

Description: Assorted sizes and shapes of permenant magnets. A very strong battery operated electromagnet

Equipment List	**Storage Location (CHEMP 130A map)**
assorted permanent magnets	**B5.3**
battery operated electromagnet	**B5.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: E43

Setup Notes: E43

PIRA #:

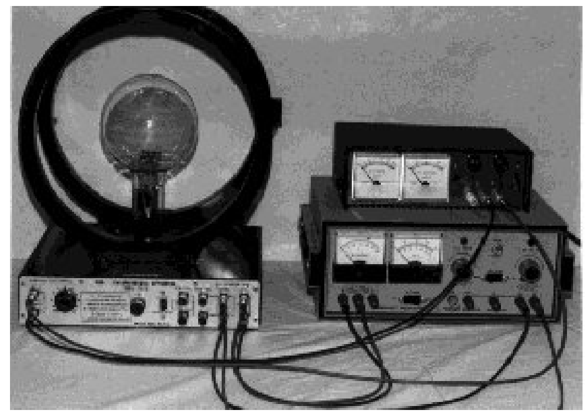
Demonstration web pages at other schools

E44: e/m Demonstration

Purpose: To show the path of electrons in a magnetic field and to find the charge-to-mass ratio.

Description:

Turn on the Heathkit power supply, which provides filament current and accelerating voltage for the electron tube. The filament current should be set to 6.3 A, and the accelerating voltage ("B^+" on supply) between 150 and 300 V -- about 200 V seems to work best. When the tube filament warms up so that the electron beam appears, explain why the beam shows the path of the electrons. The electron beam can be focused by means of the "focus" control on the e/m apparatus. Use the bar magnet to show qualitatively the effect of a field on the electron path.



Turn on the Southwestern Technical power supply that supplies current to the Helmholtz coils. Leave the controls of the power supply fixed, and vary the current to the coils by means of the current control knob on the e/m apparatus.

If you want to calculate e/m, you can read the path radius by using the calibrated mirror. This mirror attaches to the housing of one of the Helmholtz coils. (**Note:** The Southwestern Technical power supply tends to overheat, and should not be left on for extended periods of time.)

Use a close-up camera so that the class can see the electron beam.

Equipment List	**Storage Location (CHEMP 130A map)**
Kent e/m apparatus	**B4.3**
Southwestern Technical power supply	**B4.3**
Heathkit regulated HV power supply	**B4.3**
bar magnet	**B5.3**

References:

Manufacturer: Kent, Southwestern Technical, Heathkit

Manual: none

Teaching Suggestions: E44

Setup Notes: E44

PIRA #:

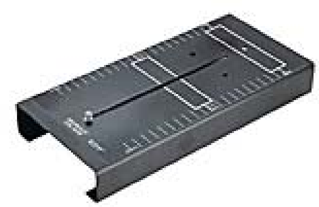
Demonstration web pages at other schools

E45: Helmholtz Coils

- **Purpose:** To create a uniform magnetic field, to show electromagnetic induction.
- **Description:**

Place a constant direct current through the coils to produce a uniform magnetic field. Use the magnetic field sensor to demonstrate that the magnetic field is approximatly uniform between the coils if the coils are spaced at distance equal to the diameter of the coils.

Place a time varying singal on the coils and use the pick up coils to demostrate Faraday's law of electromagnetic induction on the computer or oscilloscope.



Equipment List	Storage Location (CHEMP 130A map)
2-Helmholts coils (200 turn)	**B4**
Base to support coils	**B4**
pick up coils (200, 400, 2000 turn)	**B4**
Pasco signal generator	**C1**
Computer or oscilloscope to display electrical signals	**C1**
Magnetic field sensor	**B5**

- **References:**

Manufacturer: Pasco Scientific # EM-6711 , EM-6715

Manual: online

Teaching Suggestions: E45

Setup Notes: E45

PIRA #:

Demonstration web pages at other schools

E46: Magnetic Deflection-Electron Beam

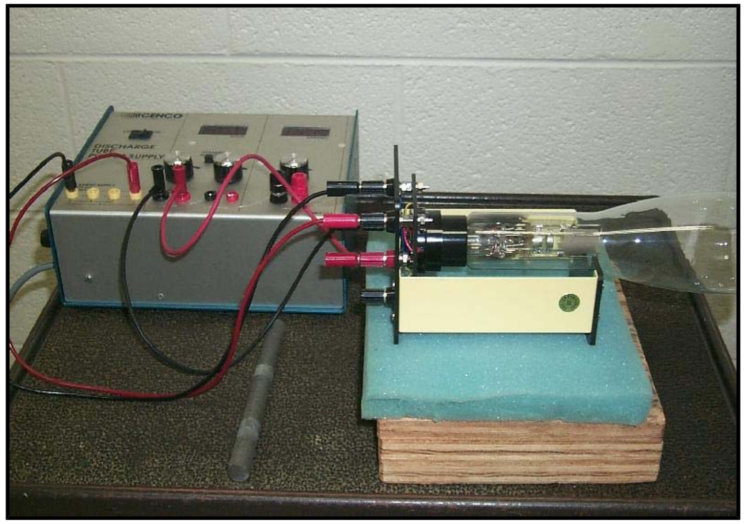
Purpose: To demonstrate that charged particles (electrons) are deflected by a magnetic field.

Description:

The apparatus consists of an induction coil, a 6-V power supply, and a cathode ray tube connected as shown in the diagram below.

The discharge tube contains a luminescent screen positioned such that the beam strikes it and is clearly visible over a distance of approximately 15 cm. A bar magnet is included to provide the deflecting B field.

A beam of electrons is set up in the discharge tube, and the magnet is brought up to the beam so that the magnetic field is perpendicular to the velocity of the electrons. Reversing the direction of the magnet naturally reverses the direction of the beam deflection.



Equipment List	**Storage Location (CHEMP 130A map)**
Power Supply	**B4**
Electron Tube	**B4**

References:

Manufacturer:

Manual:

Teaching Suggestions: E46

Setup Notes: E46

PIRA #:

Demonstration web pages at other schools

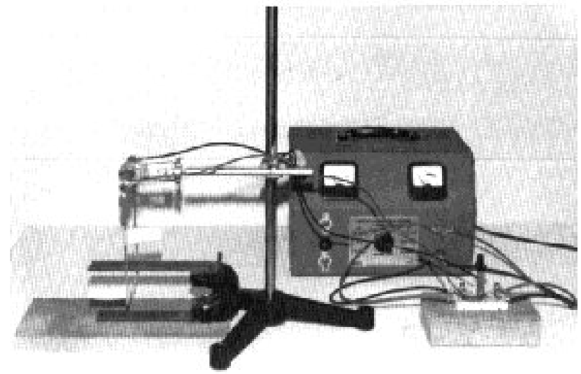
E50: Magnetic Force on a Wire

Purpose: To show the force on a current-carrying wire in a magnetic field.

Description:

Magnet arranged to produce a vertical field, rectangular loop suspended by one side so that the opposite side can move in the field, DC power supply, DPDT switch.

Turn on the power supply and throw the switch in one direction. Reverse the switch, which reverses the current through the loop. Observe the direction of motion of the wire in each case.



Equipment List	Storage Location (CHEMP 130A map)
Magnet with extention bars	**B1.3**
Trapeze wire on clamp and stand	**B1.3**
0-12 volt variable power supply	**C1.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: E50

Setup Notes: E50

PIRA #:

Demonstration web pages at other schools

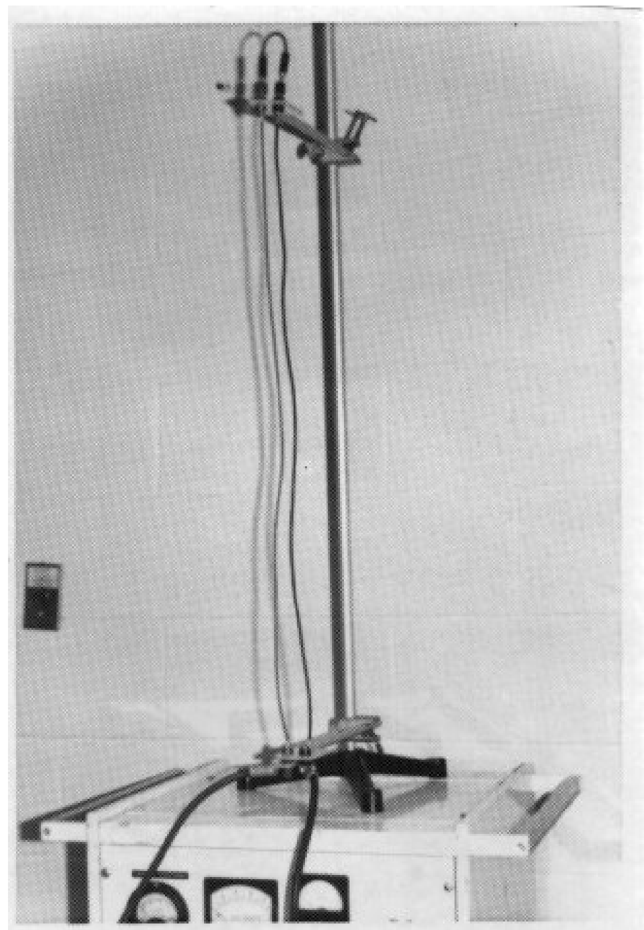
E56: Force between Parallel Currents

Purpose: To demonstrate the forces between two parallel current-carrying wires.

Description:

The apparatus consists of a ring stand supporting two parallel wires and binding posts to which large pulsed currents may be applied. The currents may be chosen to run either parallel or antiparallel in these wires. A low voltage high current D.C. power supply provides the source of current. Car battery works better than D.C. power supply.

1. To demonstrate repulsion between the wires, the currents must run in opposite directions. To do this, merely remove the connector from the two binding posts on the lower end of the stand and then connect the D.C. power supply. It is important that the current be pulsed to 6 volts for only a few seconds, as a large amount of heat develops in the wires.
2. To demonstrate attraction between the wires, the currents must run in the same direction. This may be done by having both shorts connected at the top and bottom and then connecting a terminal of the power supply to the top binding post and the other to the bottom. Again, only pulse the currents.



Equipment List

Storage Location

B6 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** E56 **Setup Notes:** E56 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

E66: Self-Inductance

Purpose: To demonstrate self-inductance.

Description:

A large solenoid connected in parallel with a light bulb, and this combination in series with a battery and a switch.

The following procedure is from Sutton:* "A large electromagnet is connected in parallel with a lamp. When this combination is connected to a source of direct current, the lamp glows. The lamp should be operated somewhat below its normal voltage. When the switch is opened quickly, the self-induced emf in the coil will be larger than was the potential drop across the lamp while the switch was closed. The lamp will therefore flash brightly before going out. The lower the power rating of the lamp, the greater the contrast. With a sufficiently large magnet, it is even possible to burn out a 10-W lamp by this inductive pulse. Slow opening of the switch makes the effect less pronounced."

Equipment List	Storage Location (CHEMP 130A map)
Primary/Secondary coils set	**B4.3**
6 volt battery	**B4.3**
Light bulb on stand	**B4.3**
Knife switch	**B4.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: E66

Setup Notes: E66

PIRA #:

Demonstration web pages at other schools

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

Virginia Tech Physics
Previous Demonstration
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Lecture demo list

E67: Pasco Lenz's Law Demonstrator

Purpose: To demonstrate Lenz's law in an interesting way.

Description:

Drop a mass through the 1.5 meter tube. It takes about half a second to drop. Then drop a magnet with an identical mass. It takes over 10 times as long to fall. As the magnet falls, it generates a current in the tube, moving in one direction above the magnet and in the opposite direction below. Both currents obey Lenz's Law and induce magnetic fields that oppose the magnet's motion.

Equipment List	**Storage Location** (CHEMP 130A map)
Pasco Lenz's Law Demonstrator	**F6**
Cylindrical magnets	**B5**

References:

Manufacturer: Pasco Scientific # MG-8600

Manual: online

Teaching Suggestions: E67

Setup Notes: E67

PIRA #:

Demonstration web pages at other schools

E68: Induced Currents-Jumping Rings

Purpose: To show the effect of currents induced in conductors near the iron core of an electromagnet excited by 60 cycle A.C.

Description:

Place an aluminum ring over the long end of the rectangular core of the solenoid and press the button on the control box. The ring will be thrown into the air. Variations include:

1. Use of a ring of lower conductivity.
2. Use of ring with gap.
3. Place the ring over short end of the rectangular core to demonstrate that a magnetic field gradient is necessary to produce a force.
4. Cool the metal rings with liquid nitrogen and get spectacular results.
5. Gently place one of the disk-shaped rings over the vertical core and let it levitate while the magnet is excited.
6. Push the LN_2-cooled ring downward near the coils and notice that the ring quickly heats.
7. Place the coil with bulb attached over the core and note the variation in bulb brightness with position of the coil.
8. Notice that when the removable section of the core is rested across the U-shaped part to close the magnetic circuit, it can be easily removed. Once the magnet is energized, it is very difficult to remove this section because of the residual magnetism.

Equipment List

Electromagnet with rectangular core, aluminum rings of various shapes.

Storage Location (CHEMP 130A map)

B5.2

References:

Manufacturer: VT

Manual: none

Teaching Suggestions: E68

Setup Notes: E68

PIRA #:

Demonstration web pages at other schools

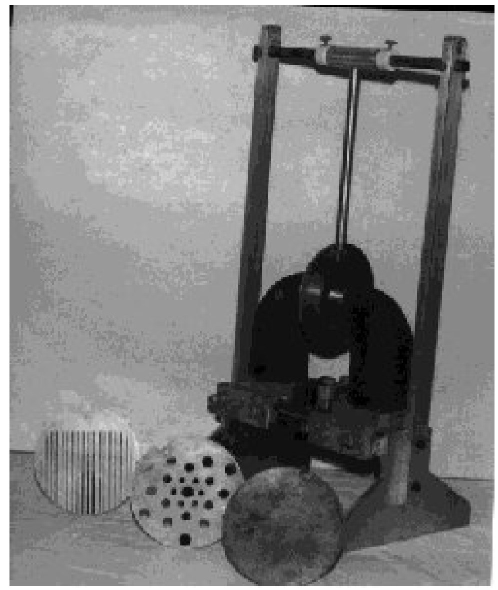
E72: Lenz's Law Pendulum

Purpose: To illustrate eddy currents and Lenz's Law.

Description:

Large magnet setup with a pendulum to swing various metal disks between the pole faces of the magnet.

Attaching different metal disks to the pendulum, note the various degrees of damping due to the induced currents in the material. Insulators and poor conductors will, of course, be less damped than good conductors. Serrated conductors will not perform as well as solid conductors.



Equipment List

Lenz's Law Pendulum

Storage Location (CHEMP 130A map)

B4.5

References:

Manufacturer: VT

Teaching Suggestions: E72

PIRA #:

Manual: none

Setup Notes: E72

Demonstration web pages at other schools

E74: LR and LRC Circuits

Purpose: To show transient response in LR circuits and LRC circuits.

Description:

For an LRC circuit, put the square-wave generator in series with the resistor, capacitor, and inductor. For LR circuits, bypass the capacitor. Connect Channel 1 of the oscilloscope across the function generator and Channel 2 across the inductor or the resistor. (For the LRC circuit, better results occur if the scope is connected to the "Lo" output.) Use approximately 1000 Hz for the LR circuit and approximately 100 Hz for the LRC circuit. Various transient responses of the instructor's choice can be demonstrated.

Equipment List	**Storage Location (CHEMP 130A map)**
Function generator	**C1**
oscilloscope	**C1**
1-mF capacitor, 100-mH inductor, 5-kW variable resistor.	**E3.4**

References:

Manufacturer:

Manual: online

Teaching Suggestions: E74

Setup Notes: E74

PIRA #:

Demonstration web pages at other schools

E76: Alternating Current LR and LRC Circuits

- **Purpose:** To demonstrate the effect of varying inductance and capacitance in LR and LRC circuits.
- **Description:**

LR Circuit at Constant *w* and Variable L

With the switch S closed, the circuit is a series LR circuit and the RMS current through the bulb is given by

$$I = \frac{V}{Z} = \frac{V}{\mathrm{sqrt}\{ R^2 + w^2 L^2 \}}$$

where V = 120 V and *w* = 120*pi Hz. The value of L is maximized when the reluctance of the flux path of the inductor is minimized, and vice versa. The value of I is thus minimum when the movable part of the iron core is in line with the rest of the core and vice versa. The brightness of the bulb increases with the power, $P = I^2 R$, dissipated in the bulb. The two equations are thus demonstrated by moving the iron core from the up and out position where the bulb is moderately bright to the down and in position where the bulb goes out.

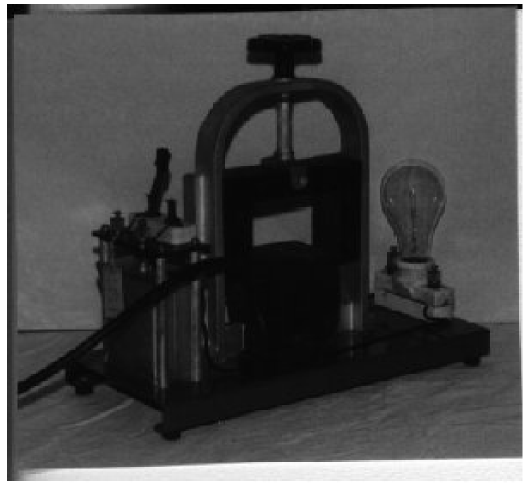
LRC Circuit at Constant *w*, R, C and Variable L. Resonance.

With the switch S open, the circuit is a series LRC circuit. The current through the bulb is given by

$$I = \frac{V}{Z} = \frac{V}{\mathrm{sqrt}\{ R^2 + (wL - 1/wC)^2 \}}$$

When *w*L = 1/*w*C then I = V/R and the current through the bulb is maximum. This is the resonance condition, *w* = 1/sqrt{ LC }, which we achieve through adjustment of the position of the iron slug in the flux path of the inductor. At both the up (or minimum L) and down (or maximum L) positions, Z is large and the bulb is dim, but we can move the slug to an intermediate position that achieves the resonance condition. Resonance is demonstrated by the bulb at full brilliance, clearly greater than the maximum brightness found when C was shorted.

A very simple and reliable demonstration, but **beware of electrocution!**



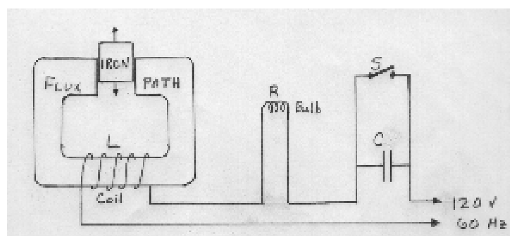
Reluctance

The apparatus also demonstrates the concepts of reluctance and the definition of L.

$$L = \frac{phi}{I} \quad \text{and} \quad phi = \frac{\text{Magnetomotive force}}{\text{Reluctance}} = \frac{M}{r} \; ;$$

$$L = \frac{M}{r*I} \quad \text{where} \quad r = \frac{l}{mu*A}$$

```
mu  = permability of iron slug
l   = length of iron slug
A   = cross section of iron slug
phi = flux through iron slug
    = flux through coil
I   = RMS current in coil
```



Equipment List

LRC circuit.

Storage Location (CHEMP 130A map)

B4.5

References:

Manufacturer: unknown

Manual: none

Teaching Suggestions: E76

Setup Notes: E76

PIRA #:

Demonstration web pages at other schools

E80: Wooden Motor Model

Purpose: To simply demonstrate the main principles of an electric motor.

Description:

A close-up camera or the Cannon Document will be needed for students to be able to be seen in the large room.

Equipment List

Wooden Motor Model

Storage Location (CHEMP 130A map)

B4

References:

Manufacturer:

Manual:

Teaching Suggestions: E80

Setup Notes: E80

PIRA #:

Demonstration web pages at other schools

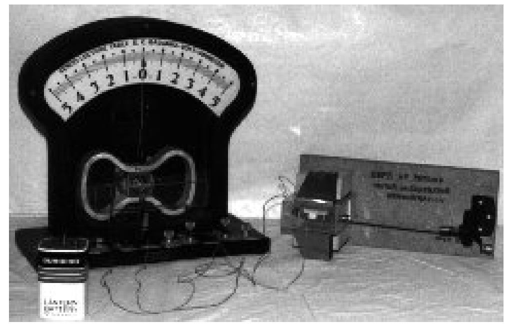
E81 Motor/Generator

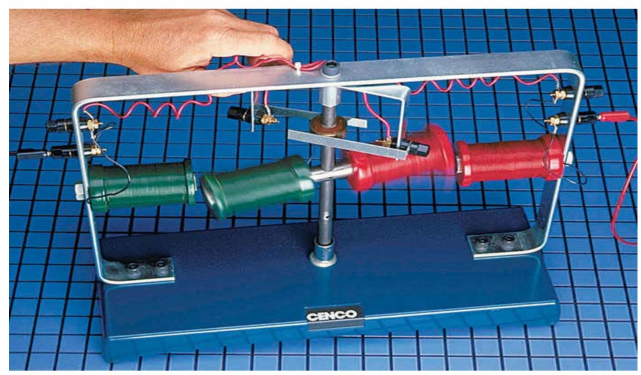
Purpose: To demonstrate the basic principles of motors and generators, and to show that the same device can serve as a motor and as a generator.

Description:

Generator. With crank shaft attached to the motor/generator armature and the leads attached to the galvanometer, turn the crank at various speeds in both directions and note the current.

Motor. Slide the armature housing so as to disengage the crank shaft. Connect the leads to the battery and note that the armature turns. (If the plane of the armature is perpendicular to the magnetic field, or nearly so, the motor will not start turning.)





Equipment List	Storage Location (CHEMP 130A map)
Motor/generator demonstrator, 1.5-V lantern battery, large galvanometer.	**B5.3**
Motor/generator model	**B5.3**
DC power supply	**C1**

References:

Manufacturer: VT, Sargent-Welch # CP79975-00

Manual: online

Teaching Suggestions: E81

Setup Notes: E81

PIRA #:

Demonstration web pages at other schools

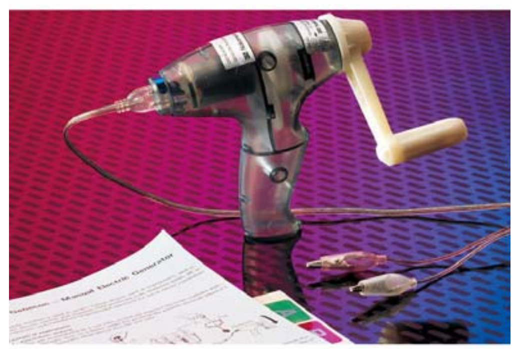
E82: Hand Crank Motor/Generators

Purpose: to show working motor/generators.

Description:

Use one as a motor and one as a generator. Crank the generator and observe the motors behavior. Reverse what you call the generator and turn its crank. Show that there is not physical difference between a motor and generator.

Drive the motor with an external power supply. Use the generators to light a light bulb, etc.



Equipment List

Hand Crank Motor/Generators

Storage Location (CHEMP 130A map)

B5

References:

Manufacturer: Pasco Scientific # EM-8090 , Sargent-Welch # WL2410

Manual: online

Teaching Suggestions: E82

Setup Notes: E82

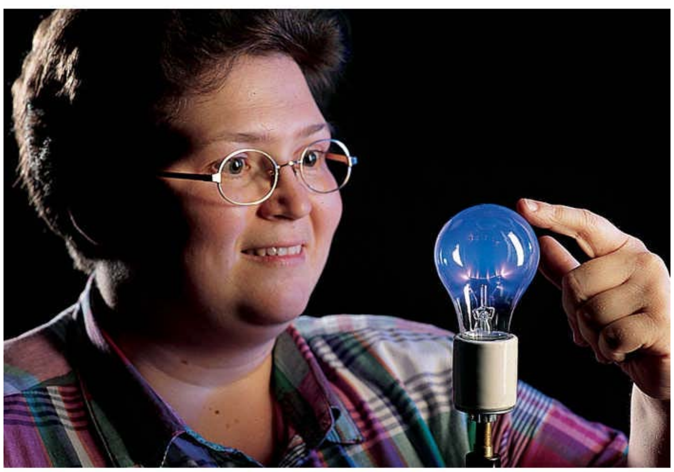
PIRA #:

Demonstration web pages at other schools

E85 Tesla Coils

Purpose: To show high voltages induced in a transformer coils.

Description:



Equipment List	**Storage Location** (CHEMP 130A map)
Tesla Coil (wand)	**B4**
Tesla Coil (vertical)	**B4**
light bulb visualizer	**B4**
Solid State Induction coil	**B4**

References:

Manufacturer: Sargent-Welch # WLS30978 , WL2390 ,WL2342 , CP30164-00

Manual:

E86: Plama Ball

Purpose:

Description:

Equipment List

Plama Ball

Storage Location (CHEMP 130A map)

B4.1

References:

Manufacturer: Sargent-Welch # WL2147A

Teaching Suggestions: E86

PIRA #:

Manual:

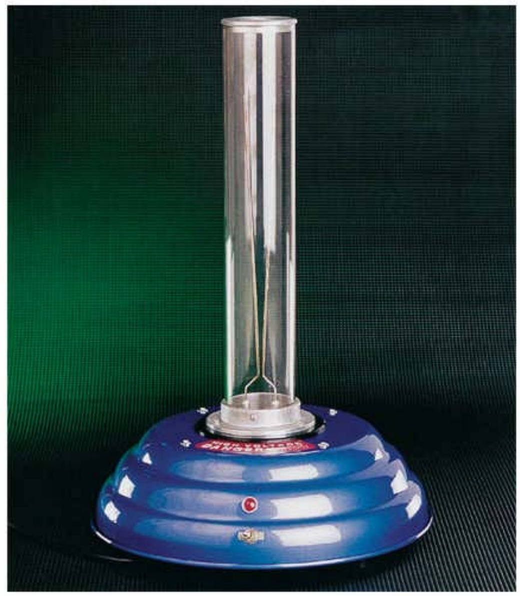
Setup Notes: E86

Demonstration web pages at other schools

E87: Jacobs Ladder

Purpose:

Description:



Equipment List

Jacobs Ladder

Storage Location (CHEMP 130A map)

B1.5

References:

Manufacturer: Sargent-Welch # WL2388

Teaching Suggestions: E87

PIRA #:

Manual:

Setup Notes: E87

Demonstration web pages at other schools

E90: Electrical Analog Meters

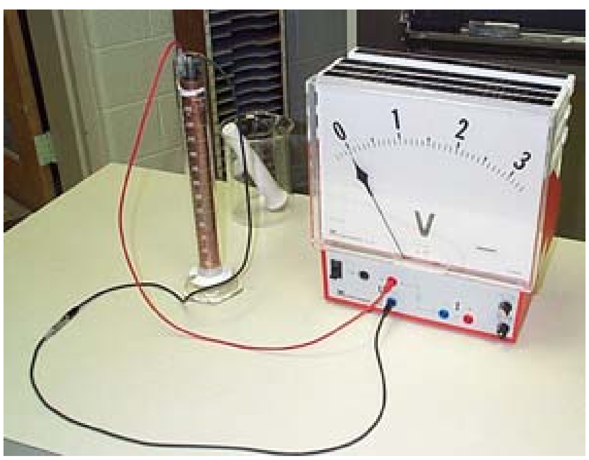
Purpose: Making analog electrical measurements for classroom demonstrations

Description: Please select the option that you want to use in the comments box of the request form.

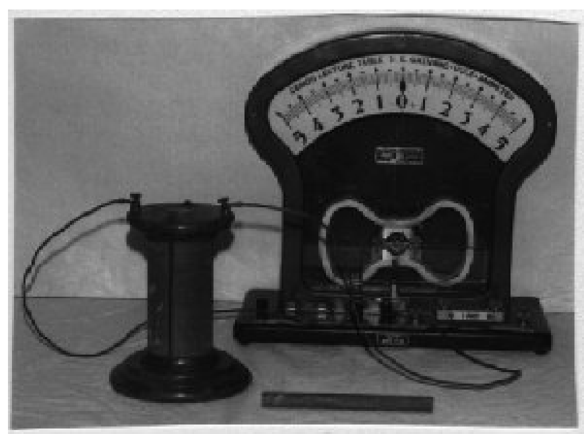
Option 1: PASCO's 750 Interface is the measurement center for the modern physics laboratory. Using a computer and the 750 Interface, students can measure force, position, temperature, pressure, angular velocity, acceleration, current, magnetic field and more. Each 750 Interface includes a built-in function generator and real-time oscilloscope mode.

The computer data can be displayed on the projectors in a variety of displays such as sweep meter, digits meter, etc.

Option 2: Analog Multimeter with different modules for measuring voltage and current in several ranges.



Option 3: Analog galvanometer with appropriate resistors and connection to function as an ammeter and voltmeter.



Equipment List	Storage Location (CHEMP 130A map)
PASCO 750 Interface	**Lecture Computer table (always out)**
Analog Multimeter	**B1**
Analog galvanometer	**B1**

References:

Manufacturer: Pasco Scientific # CI-6450, Leybold Didactic, Cenco (Sargent-Welch)

Manual: online, unknown, not available

Teaching Suggestions: E90

Setup Notes: E90

PIRA #:

Demonstration web pages at other schools

E91: Electrical Digital Meters

- **Purpose:** To measure digital signals and to measure and display analog data using a digital device.
- **Description: Please select the option that you want to use in the comments box of the request form.**

Option 1: Using a computer and the PASCO's 750 Interface, students can measure force, position, temperature, pressure, angular velocity, acceleration, current, magnetic field and more. Each 750 Interface includes a built-in function generator and real-time oscilloscope mode.

Option 2: Pasco Digital multimeter

Option 3: RSR hand held Digital Multimeter. Place the meter on the Cannon Document camera to display the measurement to the class.

- **Equipment List**

Equipment List	Storage Location (CHEMP 130A map)
PASCO 750 Interface	**Lecture Computer table (always out)**
Pasco Digital multimeter	**B1**
RSR hand held Digital Multimeter	**B1**

- **References:**

Manufacturer: Pasco Scientific # CI-6450

Manual: online

Teaching Suggestions: E91

Setup Notes: E91

PIRA #:

Demonstration web pages at other schools

E92: Electrical Signal Generators

Purpose: To produce time varying electrical signals

Description: Please select the option that you want to use in the comments box of the request form.

Option 1: This Digital Function Generator/Amplifier is actually three instruments in one: a function generator, a DC power supply and a power amplifier. Use it as a standard function generator for electronics labs. It's versatile and easy to use. But it really shines in wave and acoustics experiments. It has the power to drive speakers and wave drivers, and the ability to provide frequencies over a wide range.

Option 2: The PASCO's 750 Interface has a built-in function generator and real-time oscilloscope mode.

Option 3: WaveTec function generator

Equipment List	**Storage Location (CHEMP 130A map)**
Digital Function Generator/Amplifier	**C1**
PASCO 750 Interface	**Lecture Computer table (always out)**
WaveTec function generator	**C1**

References:

Manufacturer: Pasco Scientific # PI-9587C, CI-6450, WaveTec

Manual: online, online, unknown

Teaching Suggestions: E01

Setup Notes: E01

PIRA #:

Demonstration web pages at other schools

E93: Electrical Power Supplies

Equipment Description	Storage Location (CHEMP 130A map)
BK Precision	**C1**
Battery eliminator	**C1**
High voltage DC supply	**E5**
Low voltage DC supply	**B6**
High voltage electrostatic	**C2**
Variac variable AC transformer	**A2**

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E94: Digital Oscilloscope

Purpose: To demonstrate time varying electrical signals.

Description: The Textronix digital oscilloscope can display any electrical signal that can be captured by the oscilloscope on the video projectors in CHEP 130. This is done by connecting a VGA cable to the back of the oscilloscope and the other end to the video switch as you would a laptop computer. The Crestron controller is set up as would be done for using a labtop computer or the Cannon Visualizer document camera.

The oscilloscope can be used in the following demonstrations:

E23, E25, E45, E63, E64, E65, E74, E75,

E76, E81, E82, W04

Equipment List

Textronix digital oscilloscope

Storage Location (CHEMP 130A map)

C1

References:

Manufacturer: Textronix # TDS3012B

Manual: online

Teaching Suggestions: E94

Setup Notes: E94

PIRA #:

Demonstration web pages at other schools

Waves & Sound

W01: Tuning Forks with Resonators

W02: Tuning Fork Sets

W03: A Harmonic Cord

W04: Displaying Sound Waves

W05: Fourier Synthesizer

W07: Dual Function Generator

W08: Waveform Analyzer

W10: Mechanical Waves

W15: Transverse Wave Demonstrator

W16: Longitudinal Wave Demonstrator

W18: Ripple Tank

W20: Buzzer in a Vacuum

W28: Standing Longitudinal Waves

W30: Harmonics on a Rod

W32: Standing Waves on a String

W34: Standing Waves in an Air Column

W35: Bloogle Tube

W36: Chaldni Plates

W50: Acoustic Waves

W52: Interference

W54: Interference of Sound in a Tube

W70: The Doppler Effect

W01: Tuning Forks with Resonators

Purpose: To demonstrate sounds produced by tuning forks and show that the sound is amplified when the tuning fork is attached to a resonator.

Description:

1. Two 256 Hz tuning forks mounted on resonator boxes.
2. Rubber mallet.
3. Clamp to change the frequency of one of the tuning forks.

1. With the clamp remove, strike one of the tuning forks. Then stop the first tuning fork from ring and hear that the second tuning for
2. Place the clamp on one of the tuning fork's tines. Strike both tuning forks and hear the beat frequency. Adjust the clamp position to increase or decrease the difference in the frequencies. The computer can also be used to display the sound patterns (see W04).

Equipment List **Storage Location**

B2.1 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W01 **Setup Notes:** W01 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W02: Tuning Fork Set

Purpose: To demonstrate sounds produced by tuning forks.

Description:

Please specify in the comments box on the schedule page which of the following options you want.

(A) Five octive set (C1=128 Hz, C2=256 Hz, C3=512 Hz, C4=1024 Hz, C5=2024 Hz)

(B) Musical Pitch set (C=256, D=288, E=320, F=341.3, G=384, A=426.7, B=480, C'=512 Hz)

(C) Concert Pitch set (A=440 Hz)

Strick tuning forks with a rubber mallet or with the rubber sole of your shoe. The sound produced can be presented to the class through the lecture microphone system. The sound pattern can also be displayed using the Pasco WavePort software on the computer (see W04).

Equipment List

Storage Location

B2.1 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W02 **Setup Notes:** W02 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W03: A Harmonic Cord

Purpose: To produce a harmonic cord. The cord is three tones that interfer with each other in such a way as to be musically harmonic..

Description: Please specify which option you want.

Option1: Three tuning forks on resonator boxes (C=256 Hz, E=320 Hz, G=384 Hz).

Option2: Four tuning forks next to cylinderical resonators (C=256 Hz, E=320 Hz, G=384 Hz, C'=512 Hz)

Strike the tuning forks with the rubber mallet. As each new tone is added a harmonic cord develops. The three tone sound good together because the beat frequencies of the three tones are all multiples of 64 Hz. All the tones are multiple of 64 Hz.

This and other harmonic and anharmonic cords can also be produced using the Pasco WavePort software that is available on the lecture computer (see W04).

Equipment List	**Storage Location**
Tuning forks	**B2.1 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W03 **Setup Notes:** W03 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W04: Displaying Sounds

Purpose: To display the time varying signal from a microphone. The program can be used to display any sound source in the audible range. The program can also produce sounds through the computer's speakers.

Description:

1. Pasco Science Workshop 750 interface connected to the lecture computer.

2. Pasco DataStudio Software with the WavePort add-on installed.

3. Pasco Sound sensor connected to Analog Channel A.

Copy the DataStudio setup "w04_1.ds" found in the demonstration folder of the scratch drive to a location that you can easily access. This file can then be modified as needed to display sound as desired.

Equipment List	**Storage Location**
Pasco Sound Sensor	**B2.1 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W04 **Setup Notes:** W04 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W05: Fourier Synthesizer

Purpose:

Description:

[See Crawford, AJP 42, 278 (1974) for explanation.]

Equipment List | **Storage Location**

Pasco Fourier Synthesizer | **B2.1** CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W05 **Setup Notes:** W05 PIRA #:

Manufacturer(s): Pasco Scientific Other school's Demonstration web pages

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

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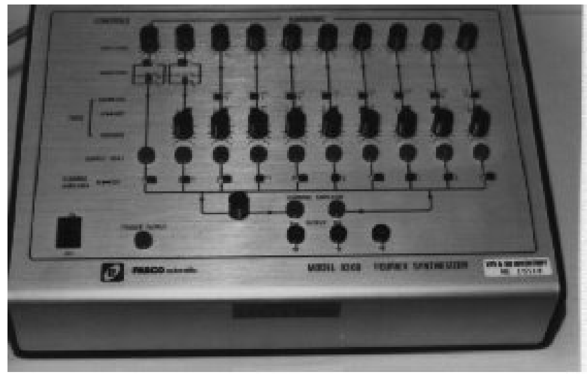
W06: Fourier synthesizer

Purpose:

Description:



Equipment List **Storage Location**

D1.4 CHEMP 130A

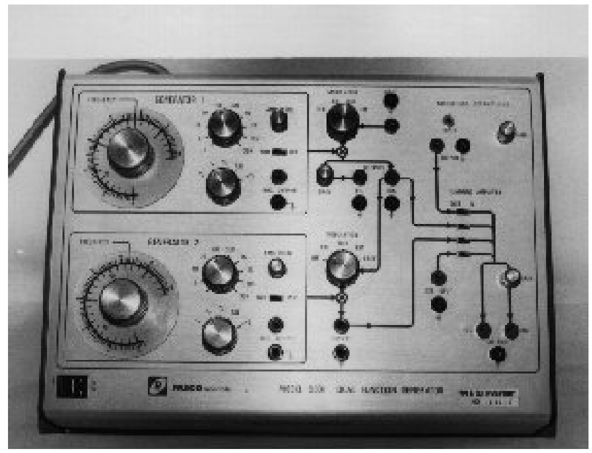
References: **Manual:** **Teaching Suggestions:** W06 **Setup Notes:** W06 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W07: Dual function generator

Purpose:

Description:



Equipment List | **Storage Location**

Pasco Dual function generator | **B2.1** **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W07 **Setup Notes:** W07 PIRA #:

Manufacturer(s): Pasco Scientific

Other school's Demonstration web pages

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

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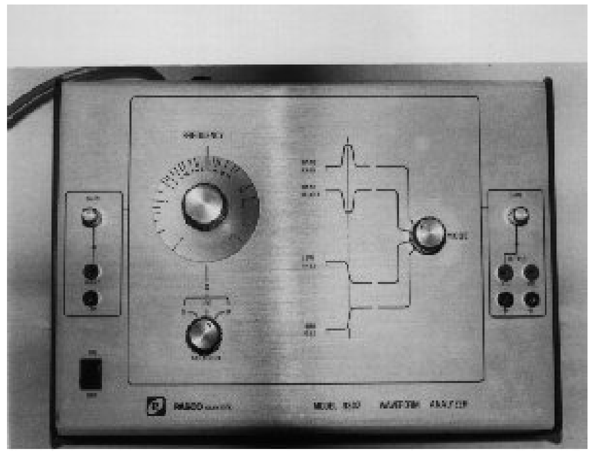
W08: Waveform analyzer

Purpose:

Description:



Equipment List **Storage Location**

B2.1 **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W08 **Setup Notes:** W08 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W10: Mechanical Waves

Purpose: To demonstrate transverse and longitudinal waves.

Description: Long thin spring, slinky, nylon cord

For transverse waves, tie one end of the long spring to a fixed object and shake the other end. With a little practice, you can easily generate several modes of standing waves. (It's sometimes more effective to hold the spring near the middle, rather than using the whole spring.) You can generate horizontal transverse waves by stretching the slinky across the floor and shaking the end horizontally. (This approach presents obvious visibility problems in most classrooms.)

You can generate longitudinal waves in the slinky as follows: Tie the cord to a fixed object, put the other end of the cord through the slinky, stretch the slinky along the cord, stretch the cord tightly, shake the end of the slinky parallel to the cord. Alternatively, you can stretch the slinky along the floor or on a long table.

You can probably find other ways of using these devices to demonstrate wave phenomena.

Equipment List	**Storage Location**
Long thin spring, slinky, nylon cord	**B2.3** **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W10 **Setup Notes:** W10 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W15: Transverse Wave Demonstrator

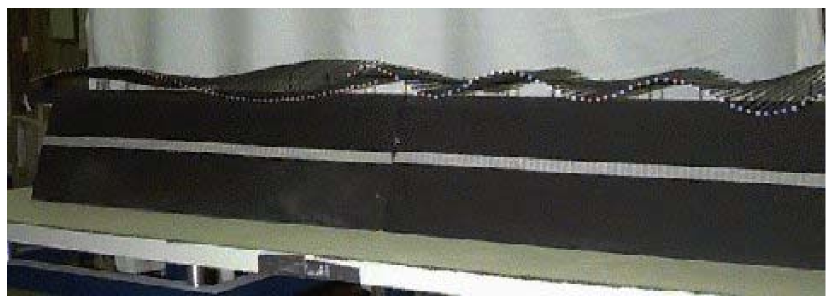
Purpose: To demonstrate mechanical waves

Description:

1. PASCO Transverse Wave Demonstrator consist of a set of rod attached to a torsional wire. When the end rod is moved transversly the disturbance is transmitted down the demonstrator.

2. Clamp to fix the end rod.

3. There are several different sections of this demonstration. these sections can be connected togther our use idividually. Please specify which pieces you want to use in the comments box of the request form.



a) Two sections with long rods. These can be connected together to make a longer demonstration.

b) Two sections with short rods. These can be connected together to make a longer demonstration.

c) One section that had varying length rods.

You can demonstrate: (1) wave propagation; (2) velocity in different media by two sections whose oscillators have different mass; (3) wavelength versus velocity and frequency; (4) reflection at fixed and free boundaries (by clamping the end if desired); (5) constructive and destructive interference; (6) standing waves and resonance (a mechanical oscillator for fixed known frequencies is available if desired); (7) reflection and transmission at media boundaries.

Equipment List	**Storage Location**
Pasco Transverse Wave Demonstrator	**E2.3 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W15 **Setup Notes:** W15 PIRA #:

Manufacturer(s): Pasco Scientific Other school's Demonstration web pages

W16: Longitudinal Wave Demonstrator

Purpose: To demonstrate longitudinal mechanical waves.

Description: PASCO Longitudinal Wave Demonstrator

You can demonstrate: (1) longitudinal wave propagation; (2) wavelength versus velocity and frequency.

Equipment List — **Storage Location**

PASCO Longitudinal Wave Demonstrator — **E2.3 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W16 **Setup Notes:** W16 PIRA #:

Manufacturer(s): Pasco Scientific # Other school's Demonstration web pages

W18: Ripple Tank

Purpose: To demonstrate two dimentional wave phenomenon

Description: The ripple tank consists of a shallow tray of water with a overhead light source to illuminate the ripples in the water.

Demonstrate parallel wave fronts and their reflection on a variety of different shaped surfaces.

Demonstrate the refraction of waves when the parallel wave fronts change wave speed when the water depth is changed.

Demonstrate parallel wave fronts as they defraction around a barier.

Demonstrate the interference of the wave produced by two point sources.

The light source can be strobed so that the wave are made to look as if they are stationary.

Equipment List | **Storage Location**

Ripple Tank | **D1.4 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W18 **Setup Notes:** W18 PIRA #:

Manufacturer(s): Sargent-Welch # CP33687-10

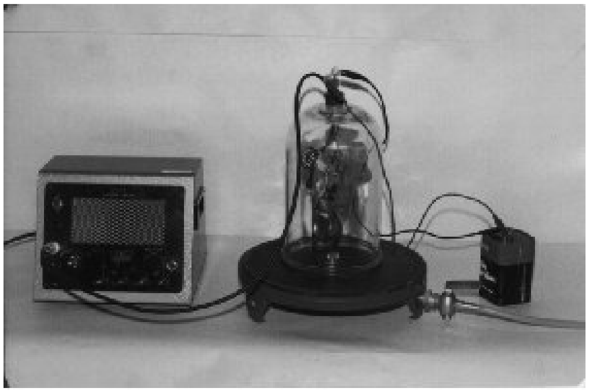
Other school's Demonstration web pages

W20: Buzzer in a Vacuum

Purpose: To demonstrate that sound will not be transmitted in a vacuum.

Description: Bell jar, vacuum pump, buzzer, microphone, audio amplifier.

Since the vacuum pump makes considerable noise, it is best to make certain the apparatus is working and then start the vacuum pump to produce the desired vacuum inside the bell jar. After the container has been evacuated, close the stopcock to the bell jar and turn the pump off. With the buzzer, amplifier, and microphone on, slowly open the stopcock so that a little air will start to enter. With the air slowly coming in, the buzzer should continue to get louder and louder until the inside pressure is the same as atmospheric pressure.



Equipment List

Bell jar, vacuum pump, buzzer, microphone, audio amplifier.

Storage Location

B3.2 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W20 **Setup Notes:** W20 PIRA #:

Manufacturer(s):

Other school's Demonstration web pages

W28: Standing Longitudinal Waves

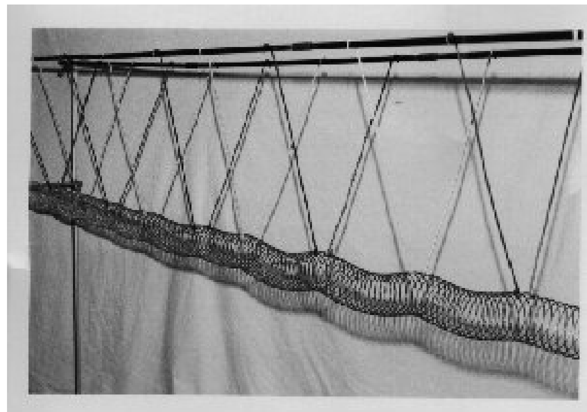
Purpose: To demonstrate several harmonics of standing longitudinal waves.

Description:

Stretched slinky supported at several points along its length.

Gently shake a support near one end of the slinky. When you find the right frequency, a standing wave will result with very little input energy. Vary the frequency to produce other harmonics.

Note: Practice is needed to get good results.



Equipment List

This demonstration in not currently available in CHEMP 130. Use W10 as a substitute.

Storage Location

CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W28 **Setup Notes:** W28 PIRA #:

Manufacturer(s):

Other school's Demonstration web pages

W30: Harmonics on a Rod

Purpose: To demonstrate the positions of nodes on a rod vibrating with its various harmonics.

Description: An aluminum rod of length L = 183 cm, with marks at L/2, L/3, L/4, L/6, L/8, and L/10.

Hold the rod vertical by grasping with two fingers at one of the marks. Tap the end on the floor and listen for the sound after the original noise burst has damped out. Holding at different marks requires nodes at different points, and thus produces different harmonics. Note that L/3 is not a node, and, therefore, you get no persistent sound when you hold the rod there.

Equipment List | **Storage Location**

An aluminum rod of length L = 183 cm, with marks at L/2, L/3, L/4, L/6, L/8, and L/10. | **F6 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W30 **Setup Notes:** W30 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W32: Standing Waves on a String

Purpose: To demonstrate standing waves on a string.

Description: Vibrator and driver, string with one end attached to the vibrator, the other passing over a pulley and attached to a 500-g mass.

Qualitative--Adjust the frequency to show the desired number of standing waves on the string. *Quantitative*--Weigh the string to determine its mass, and measure the length of the string between the vibrator and the pulley. Using the tension in the string based on the mass hanging from the end, calculate the frequency for a given number of nodes. Check that such a frequency does give the appropriate standing-wave pattern.

Note: The figure below is a flash photograph that shows the string at a given instant in its motion.

A series of strobe lights can be connected to the function generator to stop the wave motion (see the teaching suggestions page).

Equipment List	**Storage Location**
Pasco wave driver and cord	**B2.4 CHEMP 130A**
Function Generator (8 ohm impedenace) with patch cables	**C1.4 CHEMP 130A**
Clamp with pulley: clamps for supporting the cord near the wave driver	**H3.2 CHEMP 130A**
Mass set	**I2.3 CHEMP 130A**
Rod	**F6 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W32 **Setup Notes:** W32 PIRA #:

Manufacturer(s): Pasco Scientific Other school's Demonstration web pages

W34: Standing Waves in an Air Column

Purpose: To demonstrate standing waves in an air column.

Description: A sets of telescoping, nested tubes with a cap to close the end; tuning fork set, mallet

Clamp the large tube to the desktop. Calculate the possible lengths of a closed air column for standing waves of 1000 Hz in room-temperature air. Note that the first few harmonics need a tube shorter than is possible with the given apparatus. For the lowest harmonic for which the resonant length exceeds that of the large tube, move the inner tubes back and forth in the vicinity of the calculated length while holding the vibrating tuning fork near the open end. There should be a noticeable rise in loudness near resonance. Do the same for higher harmonics. Discuss the mechanism of reflection of waves from the closed end of the tube.

Ask students if standing waves would occur if the end were open. Most will probably think not. Demonstrate that standing waves do occur with comparable intensity. Discuss standing waves in an open pipe, calculate the resonant lengths, and demonstrate agreement.

Equipment List	**Storage Location**
A sets of telescoping, nested tubes with a cap to close the end; tuning fork set, mallet,	**B2.4 CHEMP 130A**
meter stick.	**F6 CHEMP 130A**
C-clamp	**H3.3 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W34 **Setup Notes:** W34 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

W35: Bloogle Tube

Purpose: Twirl the bloogle tube. Different twirling speed gives a different pitch.

Description:

[See Crawford, AJP **42**, 278 (1974) for explanation.]

Equipment List | **Storage Location**

Bloogle Tube | **B2.1** **CHEMP 130A**

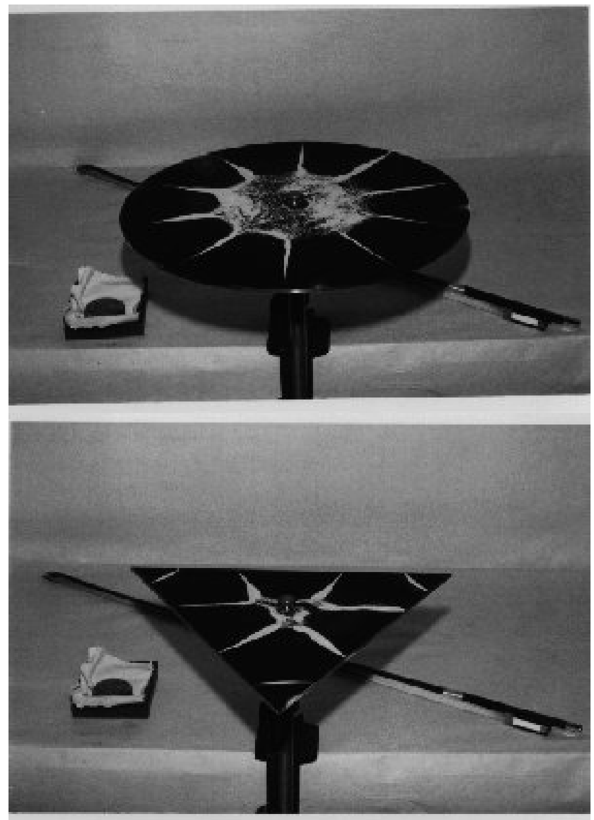
References: **Manual:** **Teaching Suggestions:** W35 **Setup Notes:** W35 PIRA #:

Manufacturer(s): Pasco Scientific? Other school's Demonstration web pages

W36: Chaldni plates

Purpose: To show two dimensional standing wave patterns in metal plates.

Description:



Equipment List | **Storage Location**

Chaldni plates and bow and rosin | B2.1 **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W36 **Setup Notes:** W36 PIRA #:

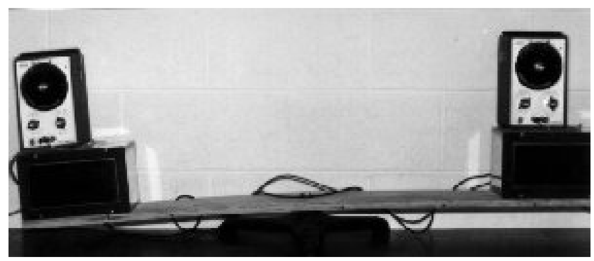
Manufacturer(s): Other school's Demonstration web pages

W50: Acoustic Waves

Purpose: To demonstrate (1) beats, and (2) interference using sound waves.

Description: Self contained audio oscillators mounted at opposite sides of a rotatable platform.

Beats: Two units (each consisting of an audio oscillator, power amplifier, and speaker) are used to demonstrate beats. The packages are self-contained and all you need to do is plug them in and turn on the power to the audio oscillators. The power control for each unit has been wired through the audio oscillator off/on switch. Make certain the audio generators are set on sine wave instead of square wave or you will get junk.



The best frequency response for this system seems to be between 300 and 1000 Hz. Set one oscillator on about 700 Hz and adjust the other to about 700 Hz; behold, just as expected, beats.

Interference: To demonstrate interference, turn off one oscillator and disconnect that speaker from its power supply by disconnecting the jumper wires between the "A" and "B" jacks on the back of that speaker enclosure. Use the long leads supplied to interconnect the "B" jacks between the two speaker enclosures. (Observe color coding.) Adjust Unit B to about 700 Hz with the volume all the way up. Have the students cover their left ear and turn their right ear toward the speaker. Now, have them move their heads back and forth about a half meter and they should detect maxima and minima.

Equipment List	**Storage Location**
Self contained audio oscillators mounted at opposite sides of a rotatable platform.	**F4.2 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W50 **Setup Notes:** W50 PIRA #:

Manufacturer(s): VT

Other school's Demonstration web pages

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

Virginia Tech Physics Previous Demonstration Next Demonstration Lecture demo list

Virginia Tech Department of Physics

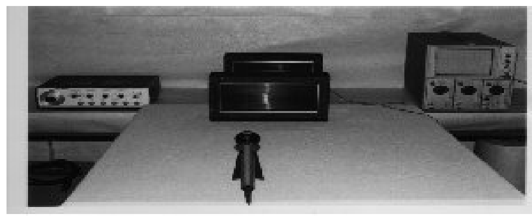
W52: Interference

Purpose: To demonstrate constructive and destructive interference using sound waves.

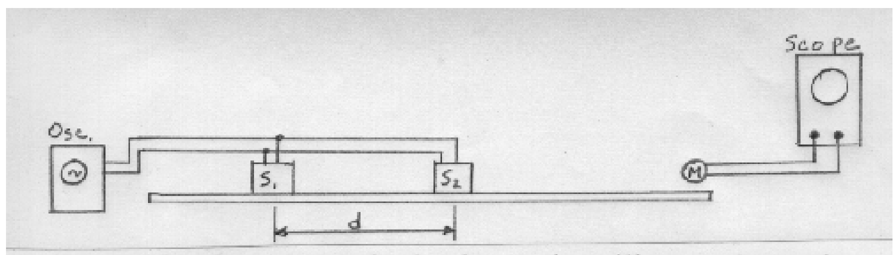
Description: Audio oscillator, 2 speakers, microphone, and oscilloscope

Connect the microphone to the oscilloscope. Connect the oscillator to each speaker separately. Students should hear the same tone and see the same type of sine wave pattern on the scope.

Now connect the oscillator to both speakers. By varying the distance d, students can hear a tone of the same frequency but higher or lower intensity. They can also see the differences on the scope.



Complete destructive interference cannot be produced because of reflections, but it is easy to show that you get constructive interference if



$$\frac{d}{\lambda} = n = 0, 1, 2, 3, 4, \ldots$$

and destructive interference if

$$\frac{d}{\lambda} = n = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}, \ldots$$

$$\lambda = \frac{\text{speed of sound in air}}{\text{frequency of oscillator}}$$

Equipment List **Storage Location**

Audio oscillator, 2 speakers, microphone, and oscilloscope **B2 CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W52 **Setup Notes:** W52 PIRA #:

Manufacturer(s): VT Other school's Demonstration web pages

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

Virginia Tech Physics | Previous Demonstration | Next Demonstration | Lecture demo list

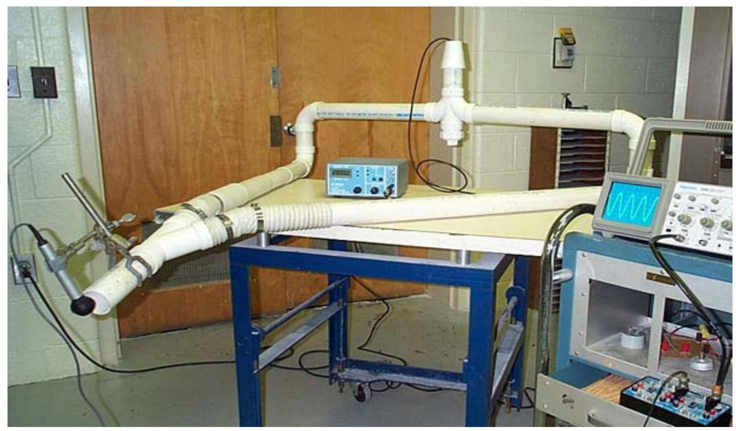
Virginia Tech Department of Physics

W54: Interference of Sound in a Tube

Purpose: To demonstrate interference of sound for a geometry that is similar to that typically considered in discussing double-slit interference of light.

Description:

Triangular arrangement of tubes having a speaker at the center of the base and a microphone where the tubes come together at the apex of the triangle; function generator; oscilloscope connected to the output of the the microphone. One leg of the triangular tube telescopes so that its length can be changed.



Discuss the conditions for constructive interference at the position of the microphone. Turn on the function generator set for about 2000 Hz, and find points of constructive and destructive interference by observing the loudness level and by the display on the oscilloscope. Show that, for constructive interference, the length of one side can be changed by a whole number of wavelengths to return to constructive interference. Measure the length change for one side between positions of maxima. Use this information to calculate the speed of sound (or some other permutation of such a calculation).

Equipment List **Storage Location**

This demonstration in not currently available in CHEMP 130. **CHEMP 130A**

References: **Manual:** **Teaching Suggestions:** W54 **Setup Notes:** W54 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

A/V Mechanics Fluids Heat E&M Waves Light Modern Resources

Virginia Tech Physics Previous Demonstration Next Demonstration Lecture demo list

W70: The Doppler Effect

Purpose: To illustrate qualitatively the Doppler effect in sound.

Description: A small speaker connected to an oscillator by a flexible cable.

Turn on the oscillator and set it to a frequency of about 600 Hz. Twirl the speaker about an axis parallel to the front of the classroom. The class will hear a rise in pitch as the speaker approaches and a drop in pitch as it recedes.

Equipment List	Storage Location
speaker	B2.5 CHEMP 130A
function generator	C1.4 CHEMP 130A

References: **Manual:** **Teaching Suggestions:** W70 **Setup Notes:** W70 PIRA #:

Manufacturer(s): Other school's Demonstration web pages

Light

- L10: Multiple Images
- L12: Mirrored Cube Corner
- L13: Mirror Cube
- L15: Illusion
- L17: Refraction
- L18: Choice Uranium Oxide
- L20: Blackboard Optics
- L21: Geometric Optics
- L22: Lenses and Mirrors
- L23: Large Concave-Convex Mirrors
- L24: Total Internal Reflection
- L25: Fiber Optics
- L28: Refraction near a Hot Surface
- L30: Dispersion
- L38: 2D & 3D Interference/Diffraction
- L40: Thin Film Interference
- L50: Polarization
- L60: Light Scattering
- L70: Color Mixing Box
- L71: Colored Filters
- L90: UV Light Sources
- L95: Holograms
- L97: Interferometer

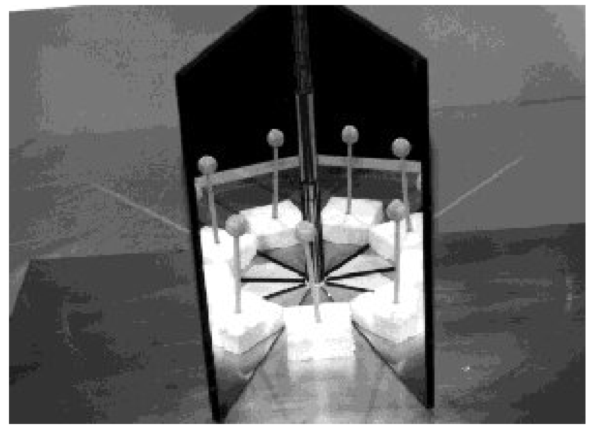
L10: Multiple Images

Purpose: To demonstrate that a single object can produce multiple images.

Description:

Show how the number of images varies with the angle between the mirrors. Explain quantitatively, if desired, using the calibrated angle scale.

Using a close up camera may help the students see this demonstration better.



Equipment List

Hinged plane mirrors and an "object."

Storage Location (CHEMP 130A map)

A2.3

References:

Manufacturer: unknown

Manual: none

Teaching Suggestions: L10

Setup Notes: L10

PIRA #:

Demonstration web pages at other schools

A/V **Mechanics** **Fluids** **Heat** **E&M** **Waves** **Light** **Modern** **Resources**

Virginia Tech Physics

Previous Demonstration

Next Demonstration

Lecture demo list

L12: Mirrored Cube Corner

Purpose: To demonstrate the principle of reflection.

Description:

Light beams hitting any one of the three mirrors from any angle are bounced off the other two mirrors and reflected back in the direction of the source. Students can also use the reflector to see a virtual image of themselves, to learn about principles of light and reflection. Includes instructions, suggested experiments, and background information.

Equipment List	**Storage Location (CHEMP 130A map)**
Corner Cube Reflector	**A1.3**
He-Ne laser	**A1.3**

References:

Manufacturer: Sargent-Welch CP33610-00

Manual:

Teaching Suggestions: L12

Setup Notes: L12

PIRA #:

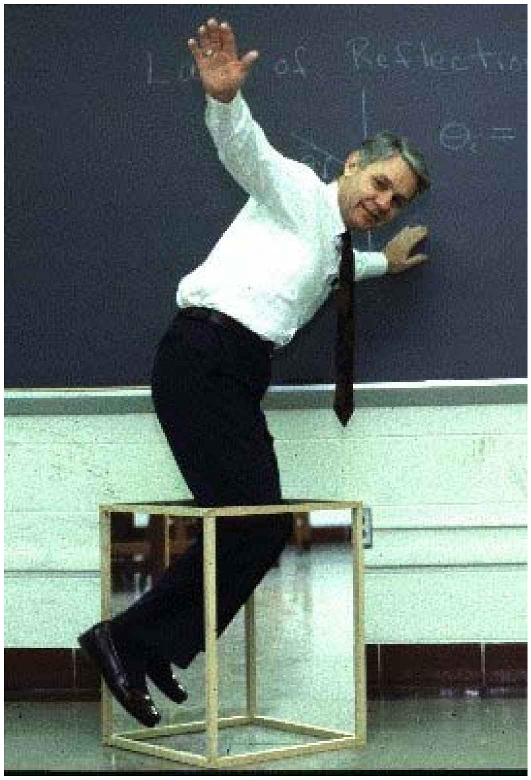
Demonstration web pages at other schools

L13: Mirror Cube

Purpose: To gain attention and demonstrate the image formed by a plane mirror.

Description:

Locate the mirror cube so that the mirror faces the class. Place one foot inside the cube in front of the mirror and the other foot inside behind the mirror. (Be sure to put the front one in first.) Bend your knees somewhat, keeping your legs parallel and equal distances from the mirror. Flap your arms to pretend to fly, or pretend to lift yourself with your index finger pushing down on a corner of the cube. As you do this, slowly lift the "front" foot while not moving either knee. To the class, you will appear to lift off the floor.



Equipment List

Cubical framework to hold a mirror along the diagonal.

Storage Location (CHEMP 130A map)

E2.4

References:

Manufacturer:

Manual:

Teaching Suggestions: L13

Setup Notes: L13

PIRA #:

Demonstration web pages at other schools

L15: Illusion

Purpose: To demonstrate the principle of reflection. It is also a very nice Wow! Ooooh! Aaahh! demonstration.

Description:

A system of concave mirrors produces images of objects placed inside it as if they were sitting on top of the device.

Aim a narrow beam of light from a penlight or laser at the image. The spot on the image where you aimed the light is illuminated.

The Mirage optical illusion is a perfect reflection and refraction demonstration for your classroom **and** it's even cool enough to amaze your friends at home.

This unique device consists of two 23cm diameter curved sections, black on the outside and mirrored on the inside. When you place an object inside The Mirage directly below the hole in the upper section, the object "appears" in the hole. Your students will be amazed when they try to grasp an object that's not really there!

Equipment List | **Storage Location (CHEMP 130A map)**

The Mirage | **A2.2**

References:

Manufacturer: Sargent-Welch # CP32531-00

Manual:

Teaching Suggestions: L15

Setup Notes: L15

PIRA #:

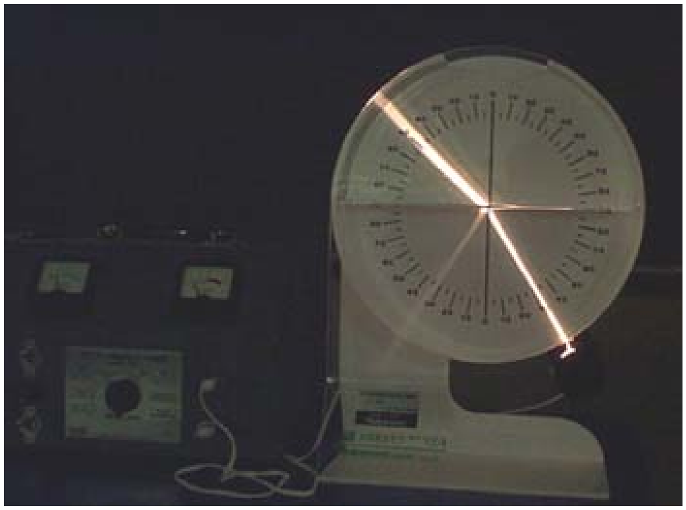
Demonstration web pages at other schools

L17: Refraction of Light

Purpose: To demonstrate Snell's law and total internal reflection.

Description:

Turn on the power supply and adjust the light source to produce a narrow beam. Move the source to various angles of incidence, and verify Snell's law. When the light beam is incident from below the water surface, both the refracted and reflected beams are visible when the angle of incidence is less than the critical angle. As the angle increases toward the critical angle, it is clear that the amount of light in the refracted beam decreases to zero as the reflected beam increases to 100% of the incident. Measure the critical angle and compare with the value predicted from Snell's law.



Equipment List

Optical Water Bath, Model RT-100N, containing water to the center of the scale; power supply.

Storage Location (CHEMP 130A map)

A2.2

References:

Manufacturer:

Manual:

Teaching Suggestions: L17

Setup Notes: L17

PIRA #:

Demonstration web pages at other schools

L18: Choice Uranium Oxide

Purpose:

Description:

Glass tube filled with distilled water and mounted above the words "CHOICE URANIUM OXIDE."

Demonstrate that when the words are read directly, they appear normal but, when viewed through the tube filled with liquid, some letters are inverted. Pass (with care) the apparatus around the classroom or otherwise make it available for viewing. Ask the students to formulate an explanation. The demonstration can also be placed on the Cannon Document Camera for class viewing.

Equipment List

Choice Uranium Oxide

Storage Location (CHEMP 130A map)

A2.3

References:

Manufacturer:

Manual:

Teaching Suggestions: L18

Setup Notes: L18

PIRA #:

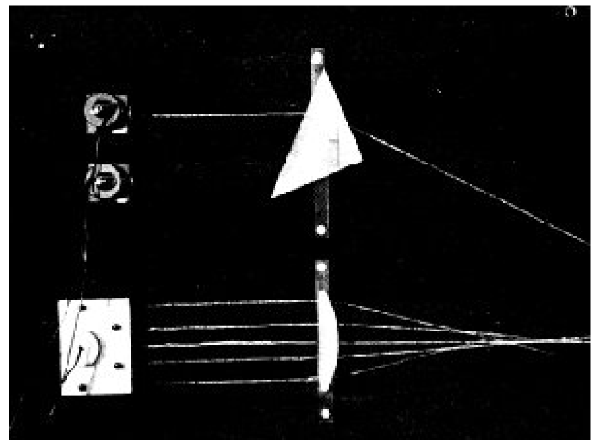
Demonstration web pages at other schools

L20: Blackboard Optics

Purpose: To demonstrate reflection, refraction, dispersion, total internal reflection performed with a single light source. With two light sources, you can demonstrate the action of lenses and mirrors.

Description:

The apparatus consists of a 120 cm x 120 cm sheet of plywood painted black, on which are mounted one or two light sources which produce an intense, well-collimated light beam whose position is visible to a large audience. Examples of single-ray and a double-ray demonstrations are shown below:



The apparatus can be set up in any classroom which can be made reasonably dark. With one light source, you can show Snell's Law and total internal reflection, and an excellent spectrum can be produced with the glass prism. With two light sources, the action of concave/convex mirrors and lenses, or combinations thereof, can be demonstrated. For more details, see the folder Blackboard Optics.

Equipment List

Blackboard Optics

Storage Location (CHEMP 130A map)

Currently not available, use L21 instead

References:

Manufacturer:

Manual:

Teaching Suggestions: L20

Setup Notes: L20

PIRA #:

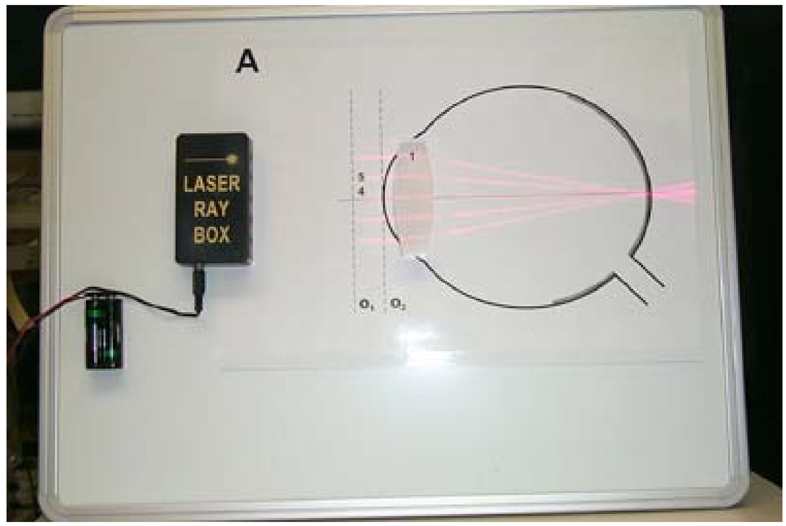
Demonstration web pages at other schools

L21: Geometric Optics

Purpose: To demonstrate reflection, refraction, and total internal reflection, and their action in mirrors and lenses. This is a more modern version of the blackboard optics demonstration in a more easily-used package.

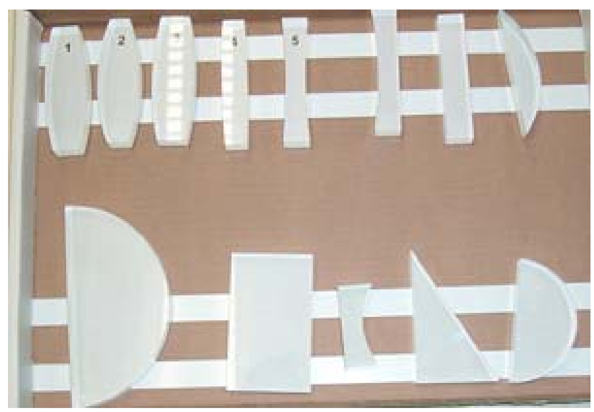
Description:

A Ray Optics Demonstration Kit consisting of a source of 5 parallel laser beams; assorted mirrors, lenses and prisms (bottom photo); a collection of background templates that schematically show the components of various optical instruments (eye, camera, telescope, etc.). The light source, templates, and optical components are held magnetically to the mounting board, which can be supported on a stand if desired.



Demonstrate the geometric optics of the various components, using the appropriate templates. The template pictured is for the human eye, which can be used to show ray behavior for a normal eye, and can also show corrections for both near-sightedness and farsightedness. The picture below shows other optical elements available in the kit.

The components can be placed directly on the whiteboards in CHEMP 130.



Equipment List

Ray Optics Demonstration Kit

Storage Location (CHEMP 130A map)

A2.1

References:

Manufacturer:

Manual:

Teaching Suggestions: L21

Setup Notes: L21

PIRA #:

Demonstration web pages at other schools

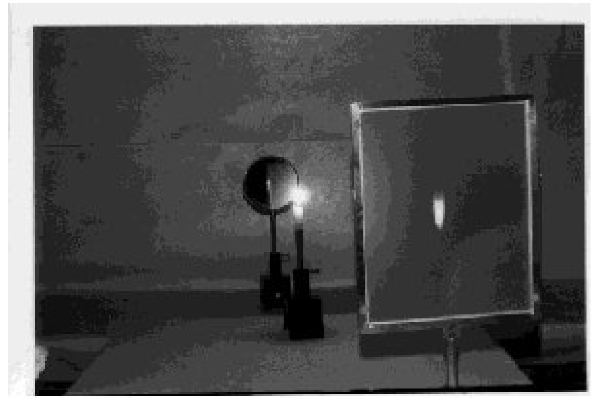
L22: Lenses and Mirrors

Purpose: To demonstrate the formation of images by a concave mirror and a converging lens.

Description:

Use the burning candle as an object and mount the mirror or lens so as to to produce an image on the ground glass. Orient the apparatus so that the class views the ground glass from the side opposite the light source. Illustrate the effect of varying the object distance. Remove the ground glass and adjust the object distance to project the image onto the classroom wall.

Compare the relative distances with those predicted by the lens/mirror equation or ray diagrams.



Equipment List

Optical bench, converging lens, concave mirror, candle, ground glass screen.

Storage Location (CHEMP 130A map) **A2.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: L22

Setup Notes: L22

PIRA #:

Demonstration web pages at other schools

L23: Large Convex-Concave Mirrors

- **Purpose:** to demonstrate the optics of convex and concave mirrors.
- **Description:**

- **Equipment List** | **Storage Location (CHEMP 130A map)**

Equipment List	Storage Location (CHEMP 130A map)
Large concave and convex mirrors	**E1.3**

- **References:**

Manufacturer:

Manual:

Teaching Suggestions: L23

Setup Notes: L23

PIRA #:

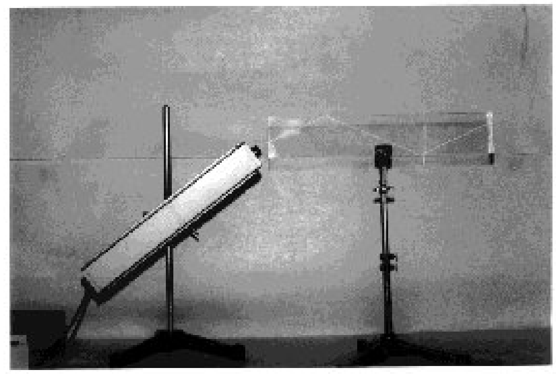
Demonstration web pages at other schools

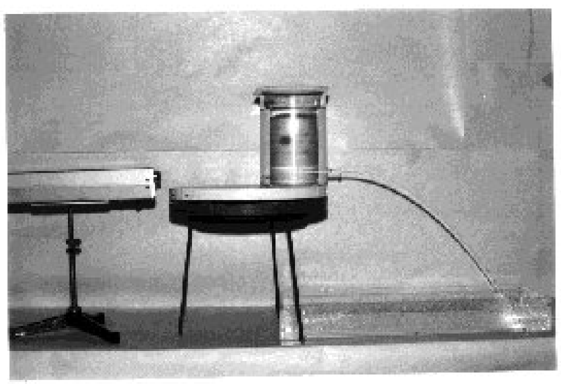
L24: Total Internal Reflection

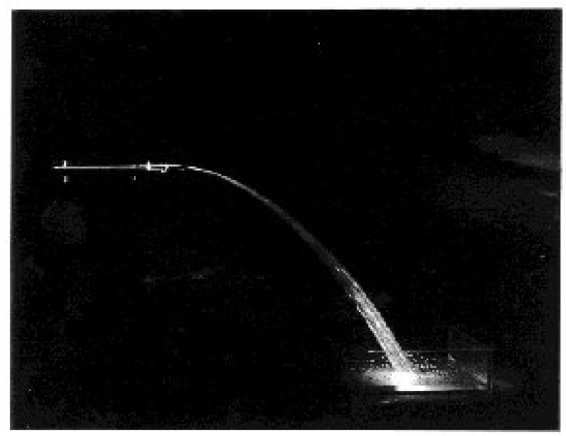
Purpose: To demonstrate total internal reflection in (a) lucite blocks and (b) a water spout.

Description:

1. Turn on the laser aimed parallel to the front of the classroom. Hold the blocks so that class members can see the beam totally internally reflected from various walls of the lucite blocks.
2. Aim the beam through the water tank at the stopper on the opposite side. Pull the plug and notice that the beam follows the water stream. The beam bends more as the stream does. Put your hand in the stream, or do other tricks to dazzle your audience.







Equipment List	**Storage Location** (CHEMP 130A map)
Lucite blocks of different shapes	**A2.4**
Laser	**A1.3**
Tank of water with removable stopper near the bottom of a side. Catch bucket.	**A2.4**

References:

Manufacturer:

Manual:

Teaching Suggestions: L24

Setup Notes: L24

PIRA #:

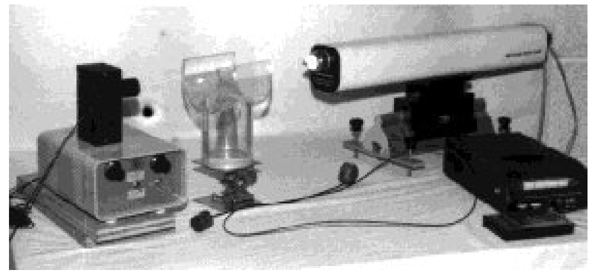
Demonstration web pages at other schools

L25: Fiber Optics

Purpose: To demonstrate the practicality of laser communication devices and the advantages of fiber optics in carrying light.

Description:

Plug in the laser and let it warm up. In the back of the laser, plug in the tape player output and set up the receiver some distance away. After demonstrating the effectiveness of this type of communication, the instructor may then exhibit how fog (from the dry ice) can eliminate the communication completely. Then show how this interference may be overcome by the use of a fiber optics wave guide.



Equipment List

Tape player, modulatable laser, light-sensitive receiver, plastic cup, dry ice, fiber optics cable.

Storage Location (CHEMP 130A map)

E2.3

References:

Manufacturer:

Manual:

Teaching Suggestions: L25

Setup Notes: L25

PIRA #:

Demonstration web pages at other schools

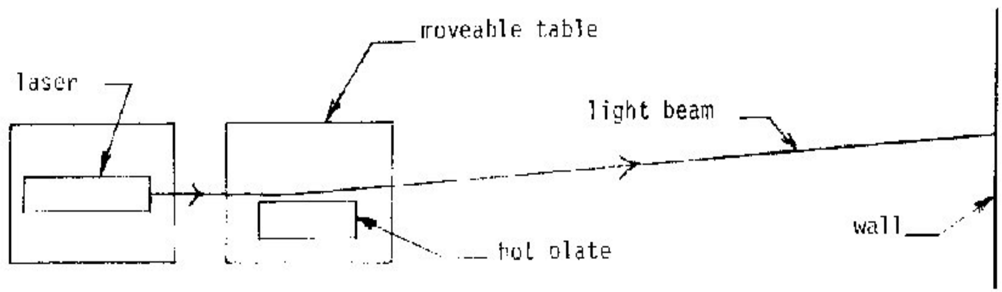
L28: Refraction Near a Hot Surface

Purpose: To show the bending of light due to temperature-dependent variation of the index of refraction of air.

Description:

Aim the laser just past the heating surface of a hot plate, nearly parallel to the surface. As the hot plate reaches its final temperature, the beam spot will move about 10 cm on a wall about 10 meters away.

Move the table containing the hot plate away from the beam and back. The beam spot on the wall will move. Using your breath or waving your hands, blow on the air near the hot plate. The beam spot on the wall will wiggle.



Top View of Apparatus

Equipment List | **Storage Location (CHEMP 130A map)**

Laser	**A1.4**
hot plate	**C3.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: L28

Setup Notes: L28

PIRA #:

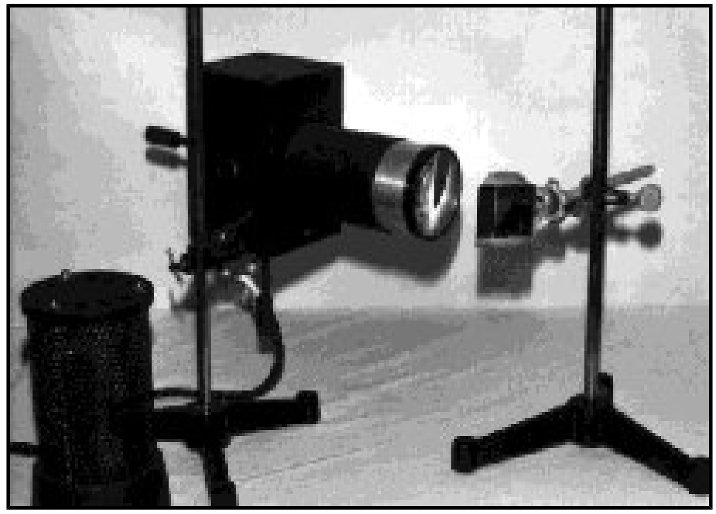
Demonstration web pages at other schools

L30: Dispersion

Purpose: To show the dispersion of white light into its component colors.

Description:

Align the system to display the spectrum on a wall or screen some distance from the source.



Equipment List	**Storage Location** (CHEMP 130A map)
Projector to give collimated beam of light	**A1.3**
Prism	**A2.4**

References:

Manufacturer:

Manual:

Teaching Suggestions: L30

Setup Notes: L30

PIRA #:

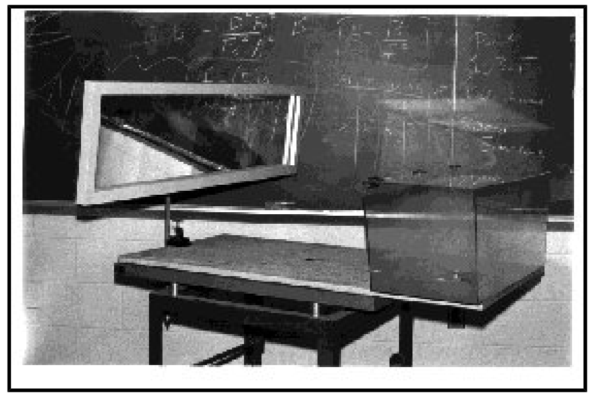
Demonstration web pages at other schools

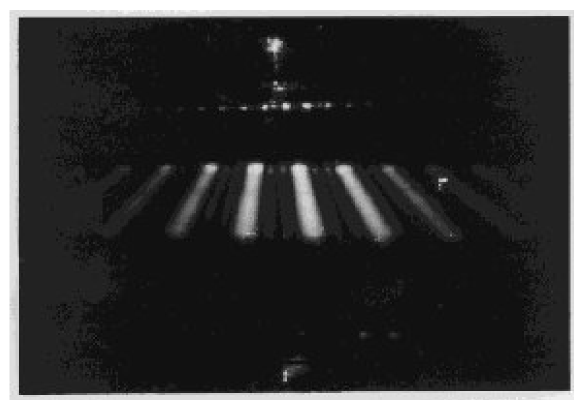
L38: 2D & 3D Interference/Diffraction Patterns

Purpose: To demonstrate single- and multiple-slit interference/diffraction patterns in two or three dimensions.

Description:

1. Two dimensional patterns: Display single and multiple slit patterns on a screen placed several meters from slits.
2. Three dimensional patterns: Place the laser and slits in the rear of the classroom and the mirror and smoke-filled box in front. Aim the beam over the heads of the students so that it strikes the mirror and reflects downward through the smoke box at an angle below the line of sight of class members. (The mirror is needed to allow placement of the box several meters from the slits and the class to view the pattern from near the forward beam direction. The back-scattered light is not intense enough to be seen clearly.) The class can see distinct three-dimensional beams in the smoke-filled region. The photograph below is a sample 4-slit pattern. The table can be rotated about an axis through the center of the mirror so that viewers near the sides of the classroom can see the pattern. In both parts 1 and 2, the observed pattern can be compared quantitatively with theoretical predictions.





Equipment List

Laser, variable-width single slit, assorted single and multiple slits and pinholes. Smoke box and mirror on moveable table, touch paper.

Storage Location (CHEMP 130A map)

Currrently not available

References:

Manufacturer:

Manual:

Teaching Suggestions: L38

Setup Notes: L38

PIRA #:

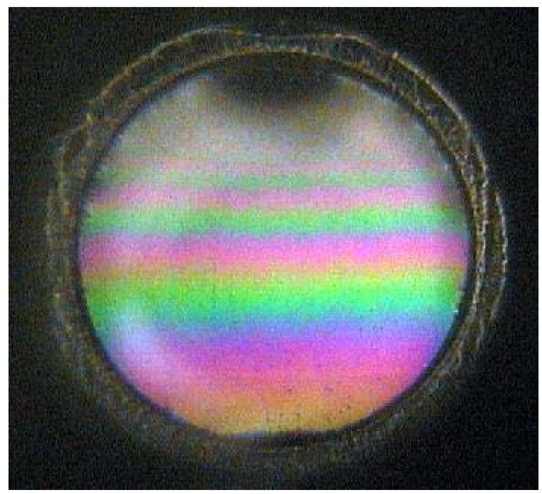
Demonstration web pages at other schools

L40: Thin Film Interference

Purpose: To demonstrate interference in the light reflected from the two surfaces of a thin film.

Description:

Place a soap film over the end of the Lucite pipe. Shine the light beam on the film and align the lens to focus an image of the film on a nearby projection screen. After allowing a few minutes for the film to stabilize, you will have an **inverted** image something like the one pictured.



Notice the **small** black region of destructive interference at the top of the film (bottom of the image) where the film is very thin. (This region gets larger with passing time. The larger dark region at the bottom of the film results because the film is too thick to give distinguishable fringes.) With a clear image, so that you can count fringes, you might do a quantitative calculation of the film thickness at some point. Otherwise, just ooh and aah!

Equipment List

Slide projector or other source of light beam, soap solution and spreader, Lucite pipe to hold film, lens.

Storage Location (CHEMP 130A map)

A2.3

References:

Manufacturer:

Manual:

Teaching Suggestions: L40

Setup Notes: L40

PIRA #:

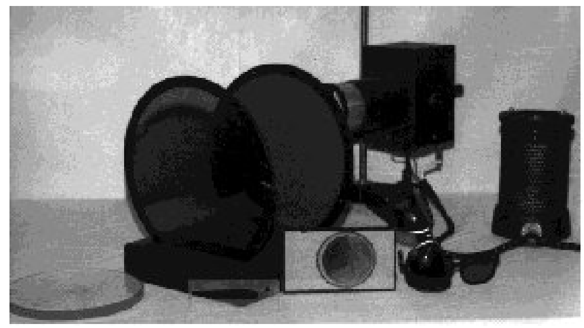
Demonstration web pages at other schools

L50: Polarization

Purpose: To demonstrate the various ways in which light can be polarized.

Description:

1. Polarization by absorption: Shine the light beam through the two sheets of polaroid. The white plastic sheet should be on the second polaroid and facing the class to facilitate viewing from throughout the room. Rotate one of the polaroids to show the effect on transmission. Show that the same effect occurs from polarizing sunglasses.
2. Polarizaiton by reflection: Aim the light beam to reflect from the glass plate at an angle near Brewster's angle. The light should reflect onto a wall. Using a sheet of polaroid, show the direction of polarization.
3. Polarization by double refraction: Return to the arrangement in part (1). Place the odd-shaped objects just in front of the analyzer (second polaroid) and show the effect of subjecting the object to stress. Rotate the analyzer, and/or object. Do the same for the pieces of tape and other assorted goodies available for this purpose.
4. Polarization by scattering: See Demonstration L60.



Equipment List

Collimated light source, two large sheets of polaroid, one with a white plastic sheet on one side, polarizing sunglasses, glass plate, miscellaneous objects made of transparent material.

Storage Location (CHEMP 130A map)

A2.4

References:

Manufacturer:

Manual:

Teaching Suggestions: L50

Setup Notes: L50

PIRA #:

Demonstration web pages at other schools

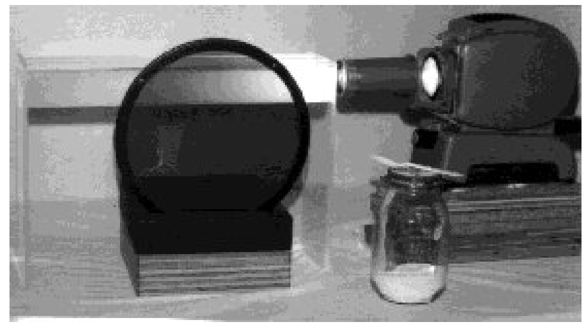
L60: Light Scattering

Purpose: To show the dependence of scattering on wavelength and the polarization due to scattering.

Description:

Shine the light beam through the water along the axis of the trough. Mix in a small amount of powdered milk. Note the color of the light scattered near the lighted end, and the color of the light transmitted through the water. Use the polaroid to show the state of polarization of the scattered light. You can use the polaroid both before and after the scattering.

Ref: H. Kruglak, Phys. Teach. **11**, 559 (1973).



Equipment List

Light-beam source, clear plastic trough filled with water, powdered milk, polaroid.

Storage Location (CHEMP 130A map)

A2.5

References:

Manufacturer:

Manual:

Teaching Suggestions: L60

Setup Notes: L60

PIRA #:

Demonstration web pages at other schools

L70: Color Mixing Box

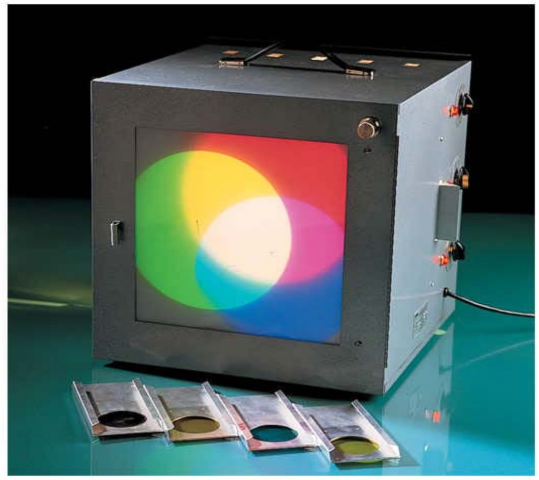
Purpose: To demonstrate an additive three color mixing scheme.

Description:

Three light sources are projected onto a screen. Each light source can have a colored filter placed in front of it creating circle of that color of light. The intensity of each light source can be adjusted to give the desired satuation.

A bar swings on a pivit behind the screen to produce muli-colored shadows that are complimentary colors to the three additive beams of light. This make for a great challenge question for the students. (See the teaching notes for ideas on how to use this color mixer)

The model shown on the right is slightly different then the model that we have. Our model is easiler to use.



Equipment List

Singerman Additive Color Mixing Box

Storage Location (CHEMP 130A map)

A1.6

References:

Manufacturer: Sargent-Welch # WL3671

Teaching Suggestions: L70

PIRA #:

Manual:

Setup Notes: L70

Demonstration web pages at other schools

L71: Colored Filters

Purpose: Demonstrate a subtractive color mixing scheme. This is the same color mixing scheme that is in color printing

Description:

We supply transparent disks of cyan, magenta and yellow for use in showing how colors are combined to form various hues.

The demonstration can be display directly to the class or can be placed on the Cannon Document Camera with the backlight on to project the image onto the wall. A standard overhead projector can also be used to project the image.

Equipment List

Subtractive Color Filter Set

Storage Location (CHEMP 130A map)

A2.3

References:

Manufacturer: Sargent-Welch # WL3664

Teaching Suggestions: L71

PIRA #:

Manual:

Setup Notes: L71

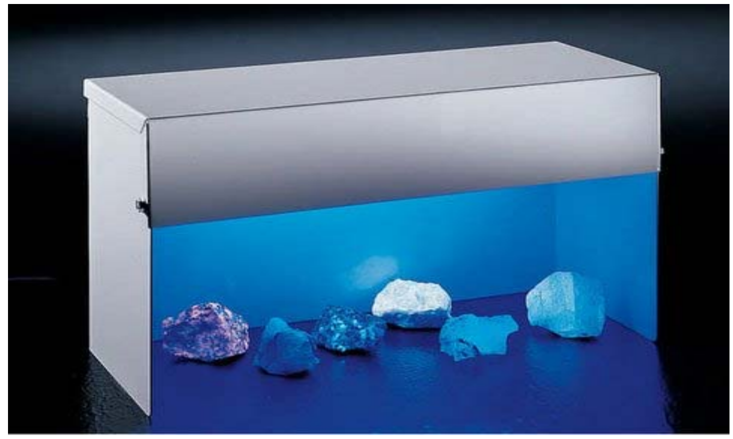
Demonstration web pages at other schools

L90: UV Light Sources

Purpose: to demonstrate the principle of fluorescence.

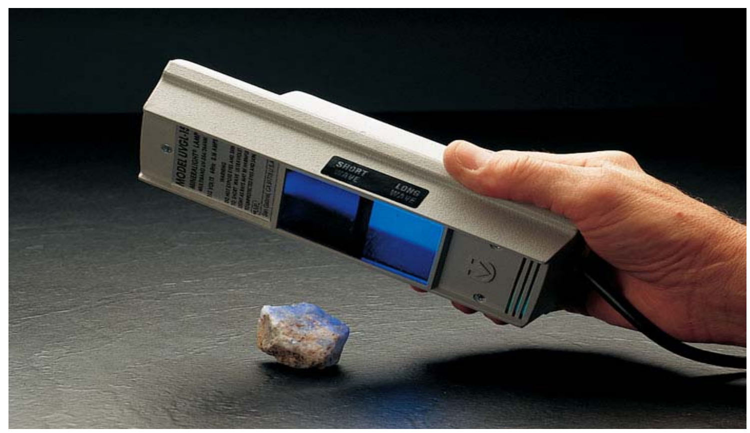
Description:

Fluorescent Minerals Set with Ultraviolet Lamp (WL0639C). Dazzle your students with a glowing display of colorful fluorescent minerals under ultraviolet (UV) light.



Hand held ultraviolet lamp, (WLS44240)

Use to visualize fluorescent minerals or for biotechnology. Rugged hand-held lamp supplies long or short UV light or both (254/365 nm).



Equipment List

UV Light Sources

Storage Location (CHEMP 130A map)

A1

References:

Manufacturer: Sarget-Welch # WL0639C ,# WLS44240

Manual:

Teaching Suggestions: L90

Setup Notes: L90

PIRA #:

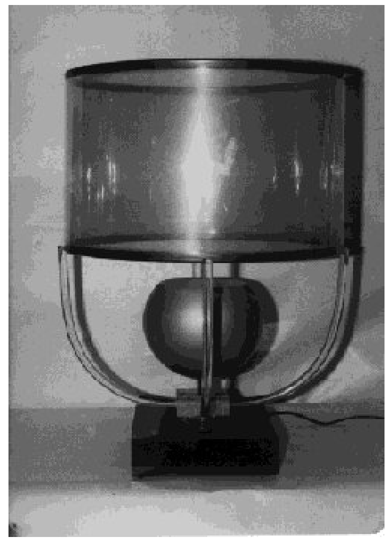
Demonstration web pages at other schools

L95: Holograms

Purpose: to show hologramic images.

Description:

White light hologram



Large Demonstration Hologram

Shows Depth and Perspective of Holographic Images

Students can clearly see a 3-D image of a magnifying lens in front of a telephone and observe the effect of the lens as if it were really present in this large 20 x 25cm transmission hologram. It is protected on both sides by glass panels. It can be used for individual viewing, in a classroom demonstration, or a school display. Any low power He/Ne laser can be used to project a real image or view the virtual image. Includes an instruction booklet.

Equipment List	**Storage Location (CHEMP 130A map)**
White light hologram	**A2.0**
Large Demonstration Hologram	**A2.4**

References:

Manufacturer: Sargent-Welch # WL3803B

Manual:

Teaching Suggestions: L95

Setup Notes: L95

PIRA #:

Demonstration web pages at other schools

L97: Interferometer

Purpose:

Description:

Key Features:

- Modes: Michelson and Fabry-Perot *(Twyman-Green optional)*
- Large Precision Optics
- 5 Kg Machined Aluminum Base

No study of interferometry should overlook the historical importance of the Michelson interferometer. Yet in the laboratory, the Fabry-Perot and Twyman-Green interferometers can be the more important tools; the first for high-resolution spectroscopy, the second for testing and producing optical components with aberrations that can be measured in fractions of a wavelength.

The PASCO Interferometer is a high-precision movable-mirror interferometer that can be used to perform Michelson, Fabry-Perot, and Twyman-Green interferometry. Mirrors are attached with thumbscrews, so it's easy to set up and change configurations.

The PASCO Interferometer can be ordered in a variety of systems. This system, the Precision (Basic) Interferometer, can be operated in either the Michelson or Fabry-Perot modes. The Complete Interferometer Systems also contain components for the Twyman-Green mode and a vacuum pump for the refractive index of air experiment (see "Related Products" below).

Equipment List

Interferometer

Storage Location (CHEMP 130A map)

A1

References:

Manufacturer: Pasco # OS-9255A

Teaching Suggestions: L97

PIRA #:

Manual:

Setup Notes: L97

Demonstration web pages at other schools

Modern Physics & miscellaneous

Q05: Electrical Discharge in Gases

Q10: Blackbody Radiation

Q15: Light Spectra of Gases

Q16: Hg Light Source

Q17: Na Light Source

Q18: Demonstration Lasers

Q20: Helium Diffusion

Q40: Radioactivity

Q45: Cloud Chamber

Q60: Proton-Proton Reaction Model

Q90: Special Relativity

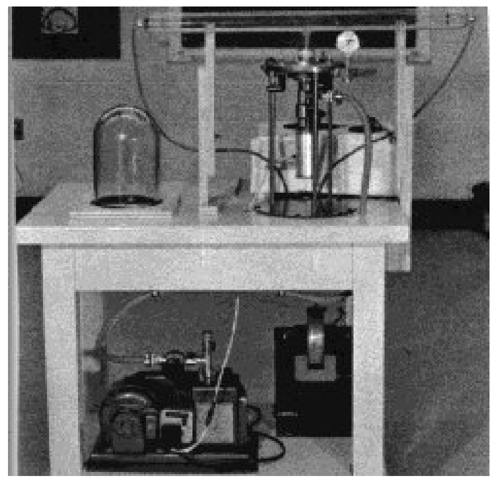
Q05: Electrical Discharge in Gases

Purpose: To demonstrate the characteristics of a gas discharge at various pressures.

Description: The apparatus consists of a vacuum system (forepump and oil diffusion pump), a discharge tube and a variac-controlled high voltage transformer -- 25 kV, SO BE CAREFUL.

Turn on vacuum system 1/2 hour before class so that no discharge can be seen when high voltage is applied (60 V on primary). Open leak and admit air (or neon) and observe:

- thin dark space next to electrodes (Aston dark space), due to inability of slow electrons from cathode to excite gas.
- thin cathode glow due to excitation of gas by cathode emitted electrons which have acquired more energy.
- cathode dark space where cathode-emitted electrons are now moving past and do not produce appreciable excitation.
- so-called negative glow extending a few centimeters due to secondary electrons from ionization of gas in the cathode dark space by cathode electrons.
- next is the Faraday dark space due to inability of the slow electrons from the negative glow to produce excitation.



Note: This description cannot be extended to the whole length of the discharge tube because the applied potential is A.C.

Increase pressure by opening wide the lead and closing off the forepump valve. Structure of discharge contracts and changes character due to shortened mean free path of electrons and changes in potential distribution.

For more detail, see *Encyclopedia of Physics, Vol. 22.*

Equipment List

Storage Location (CHEMP 130A map)

Currently not available in CHEMP 130

References:

Manufacturer:

Manual:

Teaching Suggestions: Q05

Setup Notes: Q05

PIRA #:

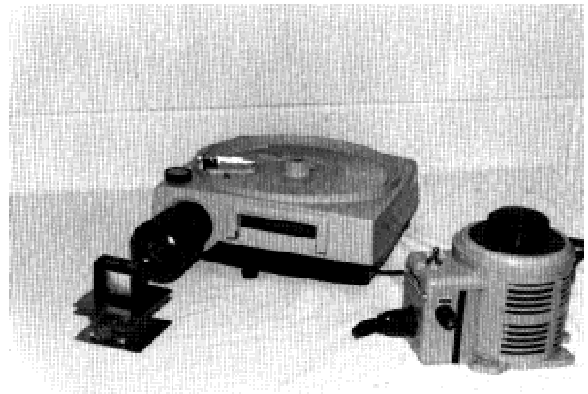
Demonstration web pages at other schools

Q10: Blackbody Radiation

Purpose: To demonstrate how the frequency of radiation is associated with the temperature of the radiator.

Description:

Place the metal "slide" in the projector and place the diffraction grating in front of the projector. After focusing a pattern on the screen, the instructor can vary the temperature of the bulb with the Variac and thus change the color spectrum produced by the grating. The projector must be properly focused to see the change in the spectrum. You can do so by focusing the undeflected image of the slit on a screen that is the same distance from the projector as is the screen on which you view the spectrum.



Equipment List

Storage Location (CHEMP 130A map)

35-mm slide projector powered via a Variac	**Currently not available in CHEMP 130.**
a metal sheet the size of a 35-mm slide with a narrow slit,	**Currently not available in CHEMP 130.**
diffraction grating.	

References:

Manufacturer:

Manual:

Teaching Suggestions: Q10

Setup Notes: Q10

PIRA #:

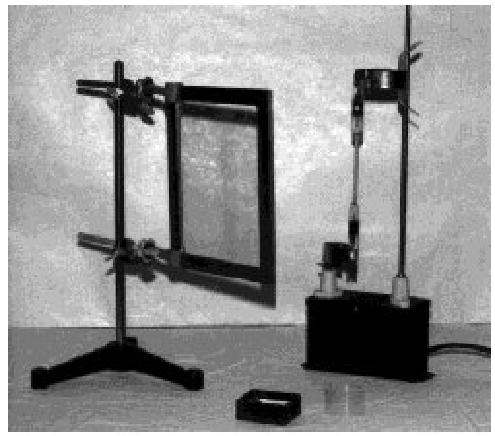
Demonstration web pages at other schools

Q15: Light Spectra of Gases

Purpose: To show the spectra of several gases excited by a discharge.

Description:

Place a discharge tube into the **5 kV** (it can tickle!) power supply and turn on the voltage. Class members can view the spectra through the large grating and/or through the small gratings given to them. Suggest that they take the gratings home and view the light from street lamps and other light sources.



Equipment List	**Storage Location (CHEMP 130A map)**
Gas discharge tubes (including H, He, Ne, Hg, Kr, O, N, CO_2, Cl)	**A1.3**
power supply	**A1.3**
large diffraction grating, small plastic gratings for distribution to class members	**A1.3**

References:

Manufacturer:

Manual:

Teaching Suggestions: Q15

Setup Notes: Q15

PIRA #:

Demonstration web pages at other schools

Q16: Hg Light Source

- **Purpose:**
- **Description:**

- **Equipment List**

  Mercury Vapor Light Source OS-9286A

Storage Location (CHEMP 130A map)

A1.6

- **References:**

  Manufacturer: Pasco Scientific # OS-9286A

  Teaching Suggestions: Q16

  PIRA #:

  Manual:

  Setup Notes: Q16

  Demonstration web pages at other schools

Q17: Na Light Source

Purpose:

Description:

Equipment List

Low Pressure Sodium Light Source

Storage Location (CHEMP 130A map)

A1.6

References:

Manufacturer: Pasco Scientific # OS-9287B

Teaching Suggestions: Q17

PIRA #:

Manual:

Setup Notes: Q17

Demonstration web pages at other schools

Q18: Demonstration Lasers

Purpose: To demonstrate the properties of laser light.

Description:

OS-8526A

Equipment List

Storage Location **(CHEMP 130A map)**

References:

Manufacturer: Pasco Scientific # OS-8526A

Manual:

Teaching Suggestions: Q18

Setup Notes: Q18

PIRA #:

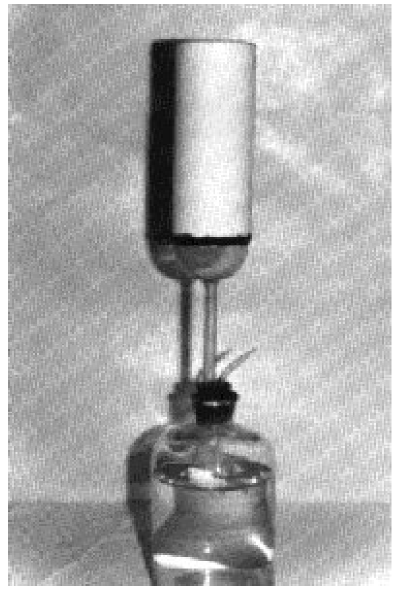
Demonstration web pages at other schools

Q20: Helium Diffusion

Purpose: To demonstrate how quickly helium will diffuse.

Description:

Place a paper bag or a suspended glass jar over the porous jar on the apparatus. Then pumping helium into the paper bag will cause water to flow out the spout because of the increased pressure due to helium diffusion.



Equipment List

Jar with water, two-hole rubber stopper, glass tube, porous jar, thistle tube, helium.

Storage Location (CHEMP 130A map)

This demonstration is not currently available.

References:

Manufacturer:

Manual:

Teaching Suggestions: Q20

Setup Notes: Q20

PIRA #:

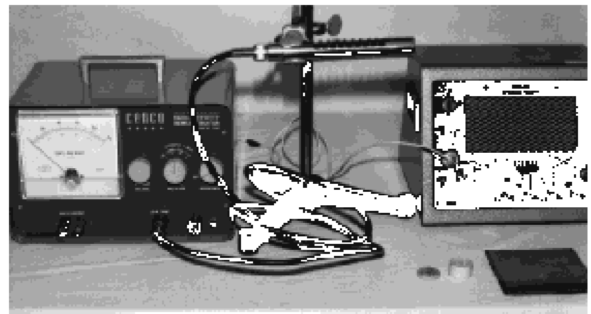
Demonstration web pages at other schools

Q40: Radioactivity

Purpose: To demonstrate radioactivity and its detection; to compare the absorption of beta and gamma rays by metals; to show the decrease in activity with time for a short-lived nuclide (optional).

Description:

Explain the basic idea of the Geiger counter and readouts. Show the effect of holding the sources near the Geiger tube. Show that the gamma rays will penetrate either side of the tube, but that the betas can reach the tube only through the thin-window side. Show the effect on the count rate of putting various thicknesses of absorber between each source and the detector. If desired, use the Union Carbide Minigenerator to produce a short-lived nuclide and observe or plot the subsequent activity as a function of time.



Equipment List

Beta and gamma sources, Geiger counter and associated visual and audible ratemeters, absorbers, Union Carbide Minigenerator.

Storage Location (CHEMP 130A map)

This demonstration is not currently available.

References:

Manufacturer:

Manual:

Teaching Suggestions: Q40

Setup Notes: Q40

PIRA #:

Demonstration web pages at other schools

Q45: Cloud Chamber

Purpose: To exhibit the tracks left by radiation from radioactive materials.

Description:

Place dry ice or liquid nitrogen between the insulating base and the cloud chamber. Pour about 1/3 the ethanol onto the felt pads on the top of the cloud chamber. Pour the remaining ethanol into the cloud chamber bottom.

Place the illumination light in the window at the back of the cloud chamber. A electric field can be set up to force the charged particles downward into the sensitive layer by rubbing the top glass with silk. A permanent magnet can be placed underneath the chamber to show the deflection of the charged particle by a magnetic field.

You can see the tracks left by the radiation from the sources and from cosmic rays by viewing the chamber from an angle of about 60 degrees from the horizontal. (Note: To make this demonstration useful for a large classroom a close-up camera should be used to view the chamber.)

Equipment List	**Storage Location (CHEMP 130A map)**
Cloud chamber on insulated base with illumination light source	**E3.4 (CHEMP 130A map)**
dry ice or liquid nitrogen (see instructions on how to obtain supplies)	Dewar **E4.4 (CHEMP 130A map)**
denatured ethanol (about 1 pint)	**F5.4 (CHEMP 130A map)**
Rare Earth permanent magnet	**E3.4 (CHEMP 130A map)**
Electrostatics kit	**C2.3 (CHEMP 130A map)**
radiation source	CHEMP 109

References: **Manual** **Teaching Suggestions:** Q45 **Setup Notes:** Q45 PIRA #:

Manufacturer(s): Supersaturated Environments Other school's Demonstration web pages

Q60: Proton-Proton Reaction

Purpose: To simulate the effects of the electrostatic repulsion of protons in the proton-proton cycle.

Description:

The electrical repulsion of the protons prevents their coming together close enough for the short-range Yukawa force to be effective, unless the velocity of the protons is quite high-corresponding to about 10^7 K in stellar interiors. (It would be even higher if quantum tunneling were not present, but that's another demo.) This simulation illustrates that effect, where the repulsive force of the ring magnets mimics the repulsive electric force of the protons and the binding effect of Velcro mimics the short range attractive Yukawa force. The speed of the magnet is derived from gravitational free fall; the speed of the protons is induced by gravitational heating in the star.

Put the ring magnets on the stand with the Velcro ends face-to-face. This ensures that like poles face each other and the magnets repel. Lift the upper one from 1 to 3 cm above its equilibrium point and drop it. If you didn't lift it too high, the two magnets won't join. Now lift the upper magnet about 5 cm and drop it. The Velcro ends will join and, if these were protons, a deuteron would result.

Equipment List

Wooden stand with aluminum post; 2 ring magnets with Velcro strips attached.

Storage Location (CHEMP 130A map)

D4.4

References:

Manufacturer:

Manual:

Teaching Suggestions: Q60

Setup Notes: Q60

PIRA #:

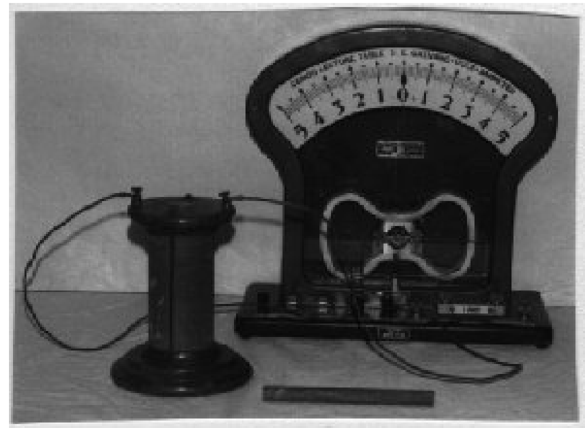
Demonstration web pages at other schools

Q90: Special Relativity

Purpose: To demonstrate relativistic effects at low velocities using electromagnetic induction.

Description:

Please read the article "Special Relativity Demonstration" by Art Huffman, Physics Dept, UCLA [Am. J. Phys **48(9)**, 779 (1980)]. Follow the instructions in this article.



Equipment List

Coil, bar magnet, large galvanometer.

Storage Location (CHEMP 130A map)

D4.4

References:

Manufacturer:

Manual:

Teaching Suggestions: Q90

Setup Notes: Q90

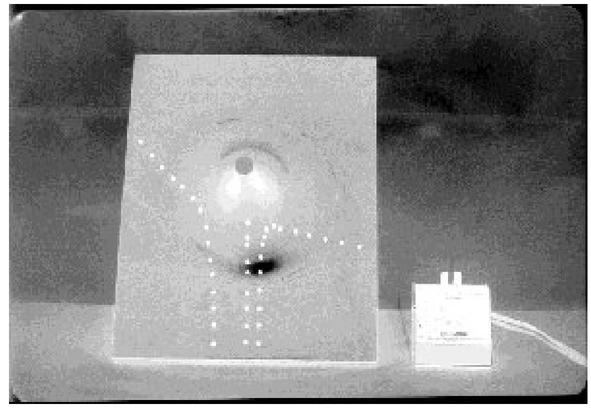
PIRA #:

Demonstration web pages at other schools

Q95: Rutherford Scattering Simulator

Purpose:

Description:



Equipment List

Rutherford scattering simulator

Storage Location **(CHEMP 130A map)**

Currently not available in CHEMP 130.

References:

Manufacturer:

Manual:

Teaching Suggestions: Q95

Setup Notes: Q95

PIRA #:

Demonstration web pages at other schools