

# EXAMPLE ASSOCIATION PVC Physics & Other Simple Demonstrations

## Dale Stille University of Iowa dale-stille@uiowa.edu





## A list of some demonstrations or parts of demonstrations which can be built using common PVC pipes, plates, and/or PVC connectors.



2<sup>nd</sup> List

• <u>www.pira-online.org</u> Our listserv is TAP-L

## Advantages of PVC

- **1.Availability and variety**
- 2.Inexpensive
- 3.Easily machined with simple hand tools = any saw, hand drill, router
- 4. Easy to assemble and glue if desired
- 5.Won't warp, crack, split, swell, and practically indestructible to student abuse
- 6. Can be easily disassembled for storage
- 7.Can withstand moderate pressures, vacuum, and LN2 temperatures

## **Disadvantages**

When burned the byproducts are toxic and carcinogenic.

Dust is also toxic. Use a mask and eye protection when drilling or sawing.



#### **1.Vacuum Cannon**

The standard vacuum cannon using 40 millimeter ping pong balls. Note that due to manufacturing changes in PVC pipe, you will now have to use clear PVC for this. A coupler will be needed if you wish to make a 10 foot cannon.



- 2. Palm Pipes and Boom Whackers
- Cut half inch PVC pipe to length needed to produce the desired note. Strike the end of the pipe on your palm. My set is colored coated the same as the boom whackers set.
- Boom Whackers are available in several sizes and in major and minor scales. Note the end caps that can be used on the pipes to produce sound an octave lower.





- 3.1 Meter Cube Unassembled and assembled
- Take four 90 degree elbows and drill another hole along the Z axis. Glue two elbows each onto the ends of four 1 meter half inch PVC pipe. Cut 8 other 1 meter half inch pipes. Assemble when needed.

Note that one cubic meter of air should have a mass of 1.25 Kg.



#### 4. Interference Horn

# Sound from a speaker directed into two different legs. One of the legs has adjustable length.



5. Grip Bar

Student tries to hold the bar horizontal as the mass is moved from close to the handles to farther away.



6. Inertia Wands

Same mass. Mass concentrated in the center at one and split in half and put at each ends on the other.



7. Pressure with Depth

Use a 2 1/2" PVC cap and part of a coupler. Membrane consists of a piece of balloon, latex sheet or latex gloves, etc.



#### 8. Slinky Holders

To keep slinkys from being tangled, stretched, and mangled. A piece of PVC pipe set into a board mounted vertically for shelf storage. OR a piece of PVC with two end caps for storage in a drawer.



- 9. Hula Hoops and Orbits Eclipse Demo 1, Eclipse Demo 2
- Normal hula hoops are hard to cut but you can now buy segmented hula hoops.
- A model made with segmented hula hoops that can show both solar or lunar eclipses. A Sun-centered model, with Earth on the outer ring, and the Moon on a red rotating ring.
- An eclipse model made with standard hula hoops. Note that this is Earth-centered, with the Sun on the outer hoop and the Moon on a rotating hoop between those two.



10. Electrostatic Rods & Rods on Pivots, or Move a Can, 2X4, & Water Stream

PVC, acrylic, and other material rods can be placed on pivots. Rub them with either silk or cat's fur. Use large PVC and acrylic rods that have also been rubbed with silk and cat's fur to either repel or attract the rods on the pivots.



#### 11. Hot Dog Cooker

Support structure for the forks is made of PVC tubing for easy dismantling and shelf storage.



#### 12. Einstein's Birthday Present

Build an apparatus from PVC that shows that a spring or a elastic band will contract when in free fall.



#### **13. Sphere Holders**

Two-inch segments of PVC tubing placed on a table or bench to keep balls from rolling off.



14. Lens Holders

Cut PVC end caps or plate to fit the lens needed for the optics rail.



#### **15. Lissajous Figures**

A PVC stand used to support a 2-D pendulum with a pen used to draw the figure.



#### **16. Linear Gauss Accelerator**

An apparatus that shows multiplication effects of magnetic fields using ball bearings and cube magnets.



17. Filament in Liquid Nitrogen – Setup and Demo

Demo: Use pliers to break the outer covering on the bulb, leaving the filament intact. Place the filament in a beaker full of liquid nitrogen and plug it in. It will glow as a normal bulb until you take it out of the liquid nitrogen into the oxygen containing atmosphere.



18. Density Balls and Rods

Cut rods of different materials and PVC to the same length for density experiments.

Balls the same size but of different materials and PVC can also be purchased.



#### **19. Wobbler or Stroboscopic Rods**

Cut half-inch PVC pipe to a length of 3 inches. Put an X on one end and an O on the other end of the pipe. Place the pipe on the table and press down on one end letting it slip out of your finger as you press and spinning. The stroboscopic effect will show you either the X or the O but not both.



#### **20. Dancing Soap Bubbles**

Cut a PVC pipe and stick a speaker on one end of it. Dip the other end in soap bubble solution and use a projector to reflect the soap film image onto a screen. Connect a speaker to a sound source and observe the oscillations of the soap film.



#### 21. Broken Ring

This demo is for the overhead projector. Send a ball around the inner diameter of the ring and when it reaches the broken part it will proceed in a straight line.



#### 22. Inertia Hammer

Drill a hole the same diameter as the PVC handle. Cut the hammer in two. Reassemble with deck screws and tighten until it grips the handle firmly. Strike the end of the PVC handle on the table and observe the hammer head falling downward.



#### 23. Electromagnetic Induction Demo– Faraday's Law

- Coils of copper magnet wire connected to LED's are wound around a 3 or 4 foot length of clear PVC. Place a magnet inside the tube and as the magnet travels from one end to the other the LED's will light up.
- **Bi-colored LED's will give interesting effects.**



#### 24. Tornado Tubes

You can cut lengths of PVC pipe and use epoxy to glue the bottles together OR you can use PVC rod and manufacture your own connector. If all else fails buy the commercial model.



#### 25. Curve Ball Thrower

Cut a portion of a tube in half and glue sand paper to the bottom of the half that is left. Make sure you attach a cord that you can wrap around your wrist so that if you slip it doesn't get away from you.



#### 26. Mechanical Equivalent of Heat – Lead

or Copper Shot

- Place a bead thermocouple into a piece of PVC that contains some lead or copper shot. Seal the ends with rubber stoppers. Observe that the temperature will go up by 7 to 10 degrees Fahrenheit when you shake the pipe.
- Note that I also use pipe insulation to keep heat transfer from my hand from interfering with the demonstration.



#### 27. Periscope

Use two large 90 degree couplers on the end of a clear PVC pipe. Cut the couplers at 45 degrees and glue mirrors onto that place. If you don't glue the periscope couplers, you can rotate one against the other for interesting effects.



28. Air Table Pucks

PVC plate can be used to manufacture your own air table pucks, conservation of angular momentum pucks, or magnetic pucks.



**29. Water Column – Barometer** 

Fill the clear PVC water column with water. Cover the end with a 3x5 card, invert and place into a swallow pan of water.

Note the rocket fins attached to the column to stabilize it when inverted.





30. Holders for Rods, Antenna, Etc.

Lengths of PVC with or without end caps attached to your shelves or shelf end caps to hold rods, antennas, and other long objects that do not fit on shelves very well.

# Some Other Possibilities



#### 1. T-Shirt Launcher



2. Large Soap Film Sheets

Other types of similar stands see:

http://www.niu.edu/stem/PDF/Hooking%20kids%20w%20haun ted%20physics%20NSTA%202011.pdf

- pages 31, 32, 33, and 35.

3. PVC Venturi Tubes see:

http://www.niu.edu/stem/PDF/Hooking%20kids%20w%20haunte d%20physics%20NSTA%202011.pdf

– Page 40 and 41



#### 4. PVC Clarinets, Flutes, Recorders & Alpine Horns

**5. PVC Flame Test – Copper Wire** 

Hi Dale,

One nice experiment is identifying PVC itself among other plastics:

- heat a copper wire (1 mm or more in diameter) in a Bunsen flame until red

- quickly touch a piece of plastic with the end of the wire (the plastic melts a bit, adhering to the copper)

- bring the end of copper wire to the flame: if the plastic is PVC the flame becomes a nice green with a bit of blue near the wire (this is because of the chlorine contained in PVC which gives copper chloride in the wire)

Greetings from Spain, Adolf acortel@xtec.cat 6. Tension and Compression

Dale,

A 10 foot length of PVC hollow stock to bend into a bow shape to demo how the outer edge experiences a tension and the inner edge experiences a compression.

Gerald Zani

Demonstration Manager Physics Brown University

(401) 863-3964

## 7. Downhill Racers – See:

http://www.exo.net/~donr/activities/Downhill\_Race.pdf

### 8. Tracks and Troughs = Split a Tube in Half lengthwise

Our machine shop guy made a bracket that would cut a PVC pipe in half to make two tracks. I'm going to put two of them on an inclined plane, place wooden blocks at the bottom of the tracks, and run a happy/sad ball race. The sad ball should bump the block, but the happy ball should knock the block over.

Scott Thomas thesat+Physics@gmail.com



9. Three Hole Can





#### **10. Pop Bottle Rocket Launchers**

- 11. 10 and 15 foot sections for Center of Mass and Resonance Frequency
- Resonance Rod Demo As an introduction to the concept of resonance, I use a 10' length of 0.5" diameter cpvc.
- The student finds the approximate center of mass of the 10' flexible hollow rod (balancing the rod on outstretched hands and slowly sliding the hands toward each other, without grasping the rod, until the hands meet at the center of mass of the rod).
- The student then starts moving the horizontal rod up and down with increasing frequency until, at the resonant frequency, the rod will have maximum movement of the rod's ends, with minimum energy input from the student's arm.
- A designated timer will announce an elapsed time of 10 seconds while the rest of the class counts cycles of the rod's movement up and down. A frequency is then calculated for the periodic motion of the rod's ends. Multiple iterations of this procedure allows a discussion of measurement error.
- A 0.5" cpvc coupler is then added to the end of the 10' rod, and an additional 5' of cpvc is added, and the new resonant frequency is determined, again timing for 10s and counting cycles. Comparison of the resonances of the 10' and 15' mechanical "systems" allows discussion of the relationship of rod length to resonant frequency, and helps solidify the 'longer is lower' idea. The demo also allows a very visual discussion of what part of the overall wavelength the 10' section of pvc represents.
- Typically the 0.5" coupling between the 10' and 5' sections will "break" apart. This "system failure" is remedied with some duct tape, but provides a segue to the Tacoma Narrows Bridge video clip which we often show later in the lesson.

Kind regards,

Chuck Chuck Griffin IBM Microelectronics SemiConductor Technology Reliability Phone: (802) 769-1277 griffinc@us.ibm.com Office: 44deg 31' 16"N, 72deg 58' 8"W If you can't find what you want locally you can go to McMaster-Carr, <u>www.mcmaster.com</u>, and probably find what you need.

# **OFFICIAL MOTTO**

# If we can't fix the problem, we'll fix the blame!!