

# Dan's Pretty Good Science #5

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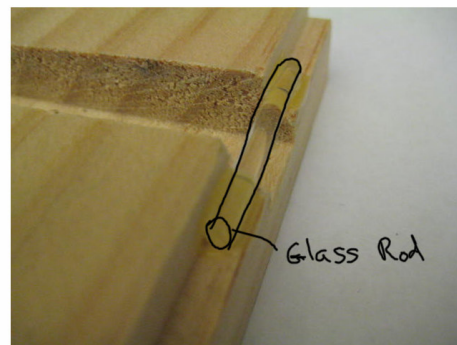
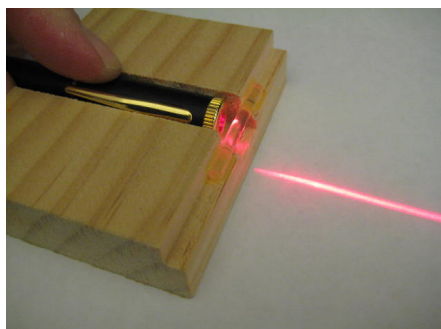
keithd@gowcs.net [www.NeatScience.com](http://www.NeatScience.com)

## Laser Line Maker Block (a modification)

An interesting modification can be made to the little “Dollar Store” lasers that you can get for a dollar. Take a short piece of a glass stirring rod about 1” long and attach it to the business end of the laser with a rubber band. This will refract the laser light so that it will make a straight line appear on the table when the laser is put down.

My modification is that I have made a wooden block where I can just place the laser into it and it already has the glass rod glued into place. When students press the laser button, the line just appears and the block remains steady on the paper for tracing or for reflector activities.

This is very useful when studying the path of light as it reflects from a series of mirrors. In my class, I have taken children’s wooden blocks and glued 1” square mirrors on a side and we do some activities with the mirrors, such as designing a laser security system around a precious object (like a Gummy Bear).



## Eye Inspection Mirror

This is an amazing little mirror that is very carefully made and is parabolic. You can hold it about 2 inches from your eye and very clearly see every little detail. You turn your head to optimize the light falling on your eye for best effect. Sold by **Edmund Scientifics** ([www.scientificsonline.com](http://www.scientificsonline.com)) for about \$10 and by **Anchor Optics** ([www.anchoroptics.com](http://www.anchoroptics.com)) for \$5. Students are really taken with this and it is also good for home use since you can see the smallest things that get stuck in your eye, and even see your contact lenses very clearly.



The only drawback is that this has a front surface mirror and this cannot be touched! It is very sensitive and clear since it does not have glass over it, which would blur the image.

## Index of Refraction Balls

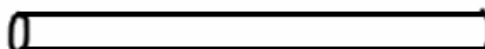
This is a great product and very inexpensive. They are little spheres made of the same material as the powder that is commonly put into baby diapers and also used for potted plants. These little spheres absorb large amounts of water and once they swell to their full size, their index of refraction is almost identical to water. The effect is that they practically disappear in water. You can hold up a beaker of water and then dip your hand

into it and pull out a whole handful of these spheres. Distilled water works best. If you have kids handle them, they will cloud the water and you should use fresh water to set it up for the next class. If you let them dry on a glass plate for a few weeks they will return to their normal size and can be reused. You can use colored water and get colored spheres. My students call them “Water Marbles”.

Sold by Educational Innovations as “Growing Spheres” (<http://www.teachersource.com>) at \$7.45 for a bag of three thousand.

### Home-made Resonance Tubes

In physics we often experiment with resonance in tubes by holding a tube with one end in some water and then having a tuning fork vibrating at the other end. By listening for the **much louder** sound when the tube length is matched to the length of the wave produced by the tuning fork, we can calculate the frequency of the fork. We can move the tube in and out of the water and find two places where it does this and that will be on half the wavelength.



It turns out that you can cut tubes to certain lengths and they will resonate at the same notes found on a piano. I have provided you with these lengths.

The tubes that I like to use are the plastic protective sleeves that you can get at your local hardware super stores. They keep broken glass from a fluorescent tube contained if it breaks. They are something like \$4 for a very long piece of it (8-12 feet). I have tried the tubes that you find in the golfing section but these are dull sounding compared to the other ones.

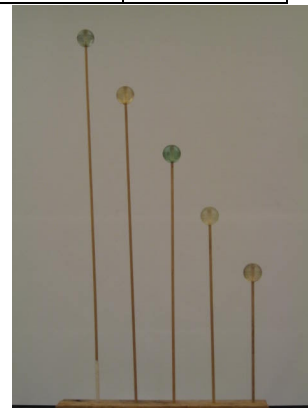
If you close one end of the tube, you will drop the note by one octave. However, if you intend to only have ones that are closed on one end, add 1 cm to the length for what is called the Open-End Correction. I close the ends on mine with packing tape.

	C	D	E	F	G	A	B
Freq. Open	264	297	330	352	296	440	495
Length Open (cm)	65	57.9	52	48.8	43.4	39	34.7
Freq. Closed	132	148.5	165	176	148	220	247.5
Length Closed (cm)	64	56.9	51	47.8	42.4	38	33.7

### Mechanical Resonance Demo

A very interesting demonstration that can be left around for students to mess with is a resonance demonstration that is very simple to make. Take a piece of 2x4 about 2 ft long and drill five holes large enough to fit some thin wooden dowels and about an inch deep. I used ¼ inch dowels. Cut the dowels to lengths 12, 18, 24, 30, and 36 inches and then just fit them into the holes. They do not have to be glued if the fit is tight. This will allow you to take it apart and easily store it.

On top of each dowel you need to attach a super ball or some other mass. The ones that I have are about 1 ¾ inch in diameter. I drilled a ¼ hole in each and glued them to the end of the dowels.



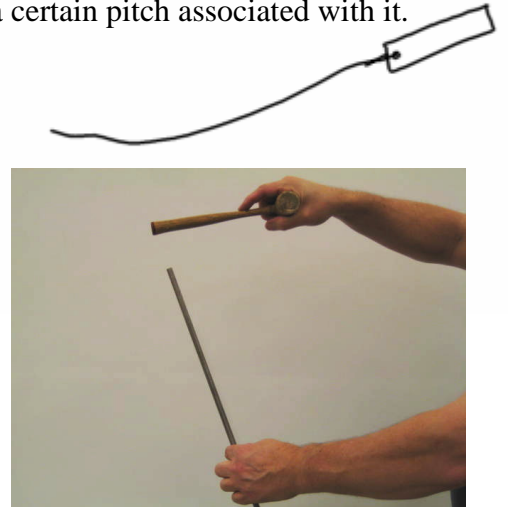
Now that it is all set up, you can shake the 2x4 in a rhythmic motion and some of the walls will sway a little but there will usually be one ball that really gets moving. You can relate this to buildings in an earthquake where some of them are at just the right height and have the right properties to shake it to pieces if the vibrations are causing the buildings to resonate.

## Bull Roarer

A popular toy of old is easily constructed from just a string and a 6" piece of flat wood or plastic (such as a piece of ruler). Put a small hole near one end of the wood and tie a string about 60cm to it. Rotate the wood in a circle in front of you at arm's length and a strange humming sound will be produced. The wood winds up first in one direction and then the other. As it winds and unwinds, the air is disturbed with a certain frequency and therefore has a certain pitch associated with it.

## Singing Aluminum Rod

You can take a piece of solid rod, I use aluminum at , and strike it on the end with a piece of wood along its axis. If you hold the rod at the exact center, the rod will resonate and sing very loudly. You can also rub the rod with a piece of leather that has been previously rubbed with violin rosin and it will also sing loudly. The part where you are holding is a node and is not affected by you holding it. If you hold the rod off center, it will just "thunk" when hit. You may find other places where the rod can be held and where it will still resonate but they will be found at other nodes.



## Saw of Death – Siren Disk

This is one of my students' favorite demos. It has to do with the frequency/pitch relationship and involves a lab rotator with a circular disk with notches along the edge. I start rotating the disk and explain to students about how anything that has a frequency of 256 Hz will produce the note of C, regardless of what is vibrating.

Using a large index card and holding along the edge, the card goes in and out of each notch and the sound is greatly amplified (relate this to a speaker cone). As the speed of the wheel increases, the pitch gets higher and higher. When it is going so fast that it seems impossible, I add some extra force to the index card and the notched wheel just cuts through it spraying little bits of shredded paper into the air. It is a very satisfactory demo. These may still be available and are called a Toothed Siren Disk.



## Prairie Fridge – Evaporative Cooler

I have one of those old fashioned canteens that you see in cowboy movies, the kind that looks like it holds about a gallon of water and is covered with what looks like a horse blanket. Actually, the blanket part was to keep the water cooler. You could get the blanket wet, and as the water evaporated it would take energy from the water with it, leaving the rest of the water with less energy (cooler).

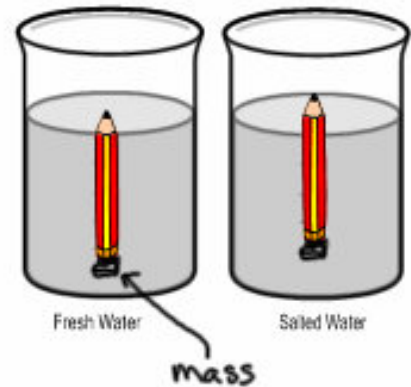


The pioneers also used a hanging series of shelves draped with damp cloth that would keep food cooler and preserving it longer. They kept the cloth damp by putting the top of the cloth into a bowl of water on the top shelf. I have no idea what this was called.



### Buoyancy Pencil (in salt and fresh water)

This activity is nice for a simple way to show differences in density and buoyancy. Just take a pencil and sharpen it. Add enough mass on the eraser end for the pencil to float with the entire sharpened end just above water, in fresh water. Then take the pencil and float it in heavily salted water and notice that the pencil floats higher.



### Newton Scale – To Stand On

I like for students to internalize things like their weight, mass, volume, etc. I always have scales around for them to measure their weight in pounds and their mass in kg. Electronic scales are easy to get at thrift stores and most have a switch for metric. I sometimes have mechanical scales where I open it up and turn the dial over and recalibrate/re-mark it for things like their weight on the moon, on Jupiter, and the Sun. I also want to make one that shows their weight in outer space (always zero). I have a place outside of my room where all of these will go once they are ready. I have two out there now and I put an email out to our district staff and I have promises of more scales.

### Funny Physics Problems

I really like to add problems to tests that have students' names and having them doing something funny where they all understand the inside joke.

Paul S. is on his way in his recently acquired "New" van to get his favorite energy drink during his 3<sup>rd</sup> period class and his velocity is...

Margaret H. wins yet another award for being nice and kicks her box of old awards across the floor with a force of 30 N for a distance...

Marcus P. shoots a series of raw potatoes from the top of his school building as a protest for the cafeteria serving Tator Tots rather than French fries. If he fires them at an angle of... and from a height of...

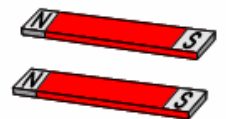
Bad Boy Georgie is standing in his tree house and kicks an empty brown bottle with an initial horizontal velocity of 6 m/s. If his tree house porch is 7 meters high, how long will it take for the bottle to hit the ground (out of his father's sight)?

Becca R. has a really vicious pet rabbit! When she comes home, the possessed bunny jumps for her throat as soon as she comes in the door. The "little", furry, fanged guy has a mass of 11.5 kg and does 191 J of work during that jump. How high is the "Rab-Attack"?

Bob's suitcase was damaged by baggage handlers and the wheels are now gone. Being stubborn, Bob decides to **pull** his suitcase rather than carry it (silent protest, you know)... what is the coefficient of sliding friction?

### How can you tell which one is a real magnet?

You are in the middle of nowhere and there is no metal anywhere. If I gave you two pieces that look like magnets but only one of them was magnetized at the factory, how could you tell which one was the magnet and which was only metal? They would both attract on either end, you know! This is a nice question for students. It turns out that you can make a "T" out of the magnets and in only one situation will one of them attract the other. There is not a field coming out of the magnet in the middle and therefore there will be no attraction unless the "live" magnet is pointed at the middle of the dead magnet.



## Disk Magnet in a Track (Lenz's Law)

A previous presentation of mine was where I took a copper tube about 1m long and dropped a metal slug through it. It takes just a second. Now drop a neodymium magnet through it, it takes about 10-15 sec. It does not even touch the sides of the tube. 1. Moving magnetic lines of force and a conductor induce a current in the conductor (tube). 2. This current has a different magnetic field associated with it, 3. and this new field opposes the neodymium magnet's field and slows it.

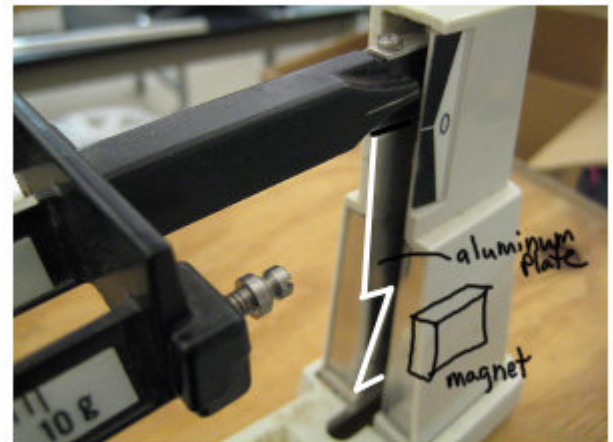


This new version has a strong disc magnet (neodymium) rolling in an aluminum track available at hardware stores where they keep “square stock” and “flat stock”.

Any other disc, like a quarter, will roll very quickly down the track. The magnetic disc will go very slowly. All of this is even more interesting when you consider that **aluminum is not attracted to magnets**.

## Magnetic Damper on a Triple Beam Balance

An example where Lenz's Law can be applied is in a magnetic damper, such as found in a lab balance. When you make your slider adjustments, the beam goes up and down and stops fairly quickly. This is because there is an aluminum plate at the end of the beam that is between magnets built into the body of the balance. The beam on older balances did not have this feature and the beam would go up and down for a very long time. Once you moved your slider again, you would have the same long wait. This damper really helps. For a demo, I will sometimes take the magnets out of the end and show students the difference.



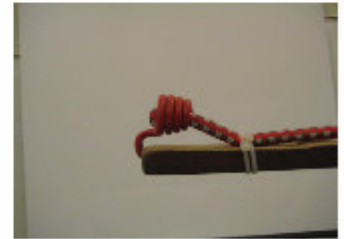
## Magnetic Damper with a Pizza Pan

A really dramatic demo is to take a neodymium magnet and hang it on a string. As a pendulum it will go for a very long time. I then put a piece of copper or aluminum just under the magnet and let it swing. The magnetic pendulum does not even swing twice! It looks like someone really put the brakes on hard. Kids are really impressed with this. A pizza pan works well but something that is heavy and copper is really impressive. If I use a copper sheet then I have to tape it down to keep it from sliding. I used a nail in this set of pictures to keep the magnet from flipping onto its edge and rubbing on the pan and ruining the effect.



## Large Spring Scale with Fluorescence Light Cover and Bungee Cord

Sometimes you just need a really large spring scale or some other force measuring device. I need one when I have a kid get on a skateboard or a cart and I apply a constant force, more than friction, to show the  $F=ma$  thing where a constant net force on a non-changing mass will give you acceleration. I start pulling the kid at some arbitrary force and I have to keep it at that force. For me to do that, I have to accelerate, as does the student.

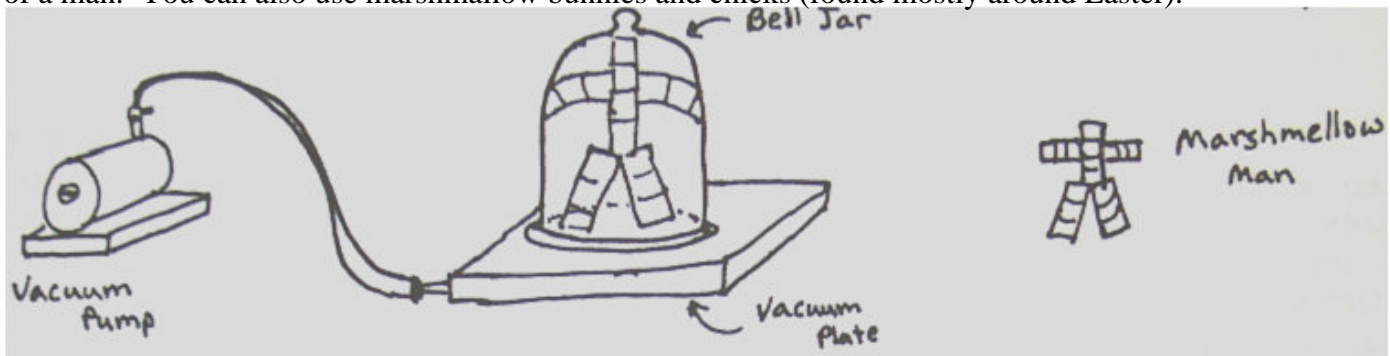


For this purpose, I built a very large spring scale using a bungee cord, some sticks, and the protective cover used for fluorescent light fixtures (since it is transparent). You can calibrate it to Newtons or you can just measure it off every 10 cm. It does not matter that the force does not change the same amount for every 10 cm, it is only to show that **whatever** force was at 30 cm will stay the same throughout the demonstration.

## Marshmallow Man and Peeps

### **Fun with a Vacuum Chamber - The Amazing Michelin Marshmallow Man**

If you have a bell jar and a vacuum pump, then here is a really fun and useful activity showing the effects of a low pressure environment on tissue. Make a "Marshmallow Man" by gluing marshmallow together in the shape of a man. You can also use marshmallow bunnies and chicks (found mostly around Easter).

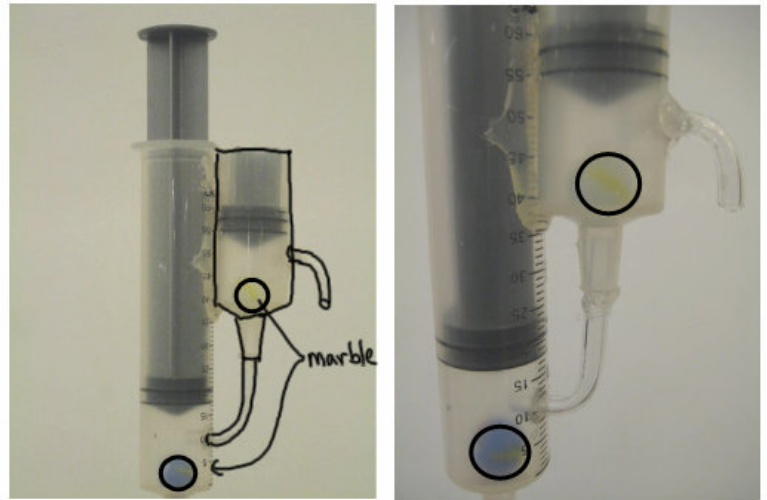


Place the marshmallow man inside the vacuum chamber and start pumping the air out with the vacuum pump. Marshmallows are made with lots of little air bubbles and the pressure inside these little air bubbles cause them to remain a certain size while at room pressure. However, when the ambient pressure is decreased the pressure difference now causes these air bubbles to expand. The marshmallow man will grow to a tremendous size compared to what it started at. At some point the little air bubbles will break and the marshmallow man will actually shrink a little in size, even at the lowest pressure inside the chamber.

As the pump is turned off and air allowed to re-enter the chamber, the marshmallow man will shrink considerably. He will end up much smaller and very wrinkled. The air that was in the little bubbles has now left and there is very little left to maintain the original size.

## Force Pump

This is the first time I have ever shown this. I designed it from two 60 cc syringes. It is a pump like you might find on a farm, but it is a version that can pump water farther or to a higher level. The plunger is pulled up to draw in the water past the blue marble. The white marble is sitting on the other opening and will not let air into the main chamber. Once the plunger is at the top and the chamber is full of water, the plunger gets pushed down and the blue marble stops the water from going out the bottom while the white marble lets the water flow past, with pressure, into the small chamber and out the spout. A hose can be attached to the spout and water can be squirted out moved higher. A nice design if I do say so myself.



Simpler pumps just lift the water and then allow it to flow out into a bucket; they do not provide the water with pressure to move up hill.

## Vacuum Bazooka

A nice demo that is good for pressure as well as impulse. A vacuum cleaner is attached to the PVC "T" with the rubber boot. A piece of PVC pipe is attached and I use a short piece at first. Turn the vacuum on and place an index card over the short end and it will stay there since the pressure inside the pipe is lower than outside the card. Air is now being drawn into the longer piece of PVC pipe. If you insert something into the longer piece of pipe it is pushed into the pipe by the higher pressure outside until it gets to the "T" and then its momentum slams it into the index card and out it goes, hopefully as high speed.

The next step is to figure out the forces and that the force only acts as long as the "bullet" is in the pipe. If you make the pipe longer, the force can act longer and the bullet has more acceleration and more velocity at the end of its trip, and more momentum. Cool demo.

