NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS

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MORE FROM SAN DIEGO

by Bill Konrad, Section Representative, OAPT

In the last newsletter I reported on the winter meeting of AAPT in San Diego, California. The whole article was devoted to the Mount Palomar Observatory. The visit to the mountain top was one of the highlights of the conference for me. In this issue I would like to report on one of the other conference sessions and share some ideas with you that you might find useful for your own classroom. The session was entitled, "Quick and Dirty Demonstrations". Many of the demonstrations were "quick" but I do not believe that any of them were "dirty". In most cases, however, they could be conducted using commonly found materials. A number of individuals contributed to this session and it was thoroughly enjoyed by all that were present. In the notes that I made during the session I placed more effort on getting the details of the presentation than on the names of the presenters. In addition to presentations from individuals significant comments that added to the demonstrations were also made by members of the audience. Below are some of the ideas that made an impression on me and may be of use to you.

Levitation and Bernoulli:

You may be aware that you can levitate a ping pong ball if it is placed in the exhaust stream from a hose connected to the output of a vacuum cleaner but did you realize that with a little practice you can also levitate a light bulb. With even more practice you can levitate three ping pong balls in one stream. The balls must be carefully placed one above the other and the stream must be vertical. Plastic 2 L pop bottles can also be supported in such a stream. Further it was suggested that by placing a plastic U tube through the such a pop bottle and filling it with coloured liquid the pressure difference between the inside and the outside (when the bottle is in the air stream) can be seen.

If you really want to get into this demonstration you may want to use a light dimmer switch to regulate the speed at which the vacuum cleaner motor runs so that you can regulate the output of air.

More on Bernoulli:

This demonstration requires a paper wind tube (a paper wind sock that is about 15 cm in diameter and about 2.5 metres long). This tube is available from Steve Spangler, c/o KCNC-TV, 1044 Lincoln St. Denver, CO 80203, 303-830-6347.

Ask a student to inflate the wind tube with his/her breath. After letting the student add 20 or 30 breaths take the tube away from the student and tell him/her that you will fill it with just one breath.

Instead of holding the tube tightly against your mouth as the student did hold the end open end near your mouth and actually use your hands to keep the end completely open. Ask the student to hold the other end of the wind tube so that the wind tube is extended and is parallel to the floor. Now take a deep breath and blow as hard as you can into the wind tube. You will see the entire wind tube fill with air. Think about it! The low pressure created by your moving breath causes the air into the room to rush into the wind tube and fill it. A simple but very impressive demonstration!

If you can not order the wind tube, make your own using tissue paper.

Cheap Magedeburg Hemispheres:

Glue an empty spool from a roll of thread over one of those long playing LP's which you do not use any more. The hole in the spool should line up with the hole in the record. Now place the record on a smooth

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SUMMER READING LIST

If you're for some interesting and informative books to read this summer try one or two of the following:

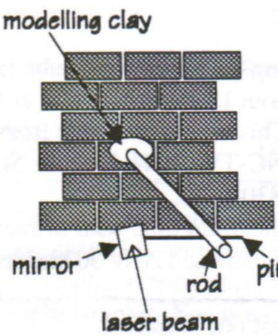
- "Surely You're Joking Mr. Feynman," by Richard P. Feynman (transcribed by Ralph Leighton):A collection of adventures about a 'curious character'.
- "What Do You Care What Other People Think?" by Richard P. Feynman: More tales from Feynman.
- "Genius," James Gleick: A biography of Richard Feynman.
- "Albert Einstein," by Ronald Clark: A biography of Albert Einstein.
- "The Sacred Beetle and Other Great Essays in Science," edited by Martin Gardner: Includes essays by such scientists as Charles Darwin, Carl Sagan, J. Robert Oppenheimer and Albert Einstein.
- "Chaos," by James Gleick: A history and overview of this new area of science.
- "The Tao of Physics," by Fritjof Capra: An exploration of the parallels between modern physics and Eastern mysticism.
- "Einstein's Universe," by Nigel Calder: A simple description of Einstein's Theory of Relativity.
- "A Brief History of Time," by Stephen Hawking: A look at black holes and the origin of the universe.
- "The Cosmic Code," by Heinz Pagel: A history and overview of relativity and quantum physics.
- "Perfect Symmetry," by Heinz Pagel: A history of modern astronomy and astrophysics and theories about the origin of the universe.
- "Gödel, Escher and Bach an Eternal Golden Braid," by Douglas R. Hofstadter: A study in logic, art, music, genetics, strange loops and how they relate to the development of artificial intelligence.
- "The Emperor's New Mind," by Roger Penrose: A look at modern physics and the possibility of developing artificial intelligence.

If you have any other titles that you think other physics teachers and students would be interested in, give me a shout (the address is on page 3) and I'll compile them into a list (include a very short description of what the book is about).

...AAPT (from page 1)

flat object. When you cover the hole in the spool with your finger there will be a fairly effective seal between the object and the record permitting you to pick up the object. Take your finger off the spool, air enters, and the object is dropped.

Immovable (?) Walls



Set up the apparatus shown at the left. Any slight movement of the wall will be amplified by the system and the spot formed by the light reflected from the mirror onto the ceiling or another wall will move when someone leans or pushes on the rigid wall.

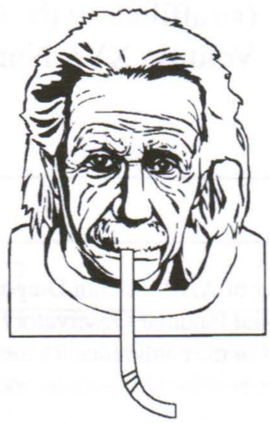
A Shocking Demonstration:

This demonstration requires a Tesla coil. A properly adjusted Tesla coil produces a vicious looking spark when held near a ground such as a water tap. Did you realize that the output of this coil is not dangerous to you. This is because of its high frequency. If you want to impress your students first have the Tesla coil throw an impressive spark at a water tap. Now take the coil and grab the metal end quickly with your bare hand. You will only experience a small shock. Now if you touch a fluorescent tube with the other hand the tube will light up. With a little bit of leg work you may be able to find a fluorescent tube from an old photo copier that gives off green light.

Where is that image?

Students often have difficulty believing that the image they see in the mirror is behind the mirror. Because of the ability of their young eyes to accommodate very quickly to different image distances they sometimes fail to realize that the images they are seeing are located in very precise positions. You can help them realize that images are in very precise locations by having them look at the images through a single lens reflex camera. The teacher advocating this demonstration suggested going to a camera store and asking the owner to donate cameras of this type that were no longer of any value for taking pictures because of a variety of failures but that still had optics that worked. If for example a student writes the word physics on a gummed label and pastes it to the surface of a plane mirror and then looks into the mirror through such a camera he/she will find that either their image or the label are in focus but that it is impossible for both to be in focus at the same time. This technique can be used with curved mirrors and lenses and can even be used to determine the apparent depth of something in an aquarium.

An Action-Reaction Brain Twizzler



Have a student place a flexible straw in his/her mouth. Have them blow through the straw as it hangs loosely from their lips and ask them to explain their observations. Most will not have too much difficulty in explaining that as the air is forced from the straw the straw pushed on the air in one direction and the air in turn pushes on the straw in the opposite direction.

Now ask them to predict what will happen when they suck on the straw. How do you explain the result?

The water hammer - A dramatic inertia demonstration

This demonstration was conducted with a long necked beer bottle filled to within 2 cm of the top with water. The demonstrator then held the bottle with one hand and rapidly jammed down on the open neck with the palm of the other hand. The result was that the bottom of the bottle broke.

The hand forced the bottle down quickly. The inertia of the water caused it to remain behind. This however created a vacuum between the bottom of the water and the bottle. This vacuum pulled the water down quickly. The inertia of the water now broke the bottom of the bottle.

There were some in the audience who felt that the demonstrator risked hurting his hand. It was suggested that a rubber mallet be used instead of the hand.

Moments to Remember

Find an old broom and find the point at which it balances. Now carefully cut the broom at this point and then by drilling a hole in one side and placing a pin in the other put the broom back together. Have students respond to the following riddle. Assume that this broom is made of gold and that two people each want an equal share of the gold. Could we divide it like this: Balance the broom, pull it apart at the balance point and give one half to each of two students. A quick mass determination will of course reveal that the two halves are not equal in mass.

Eye Defects and Glasses

This is an idea that does not originate at AAPT in San Diego but one that just came to me recently. Students are usually amazed that I can tell them what eye defect their glasses are correcting sim-

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Membership Due?

The date on your address label is the expiry date for your membership. If it says **June 93**, your membership has already expired. You may use the coupon below (or a reasonable facsimile) to renew it.

Membership Application Renewal

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$8.00 per year, payable to the OAPT

Send to: Ernie McFarland, Department of Physics,
University of Guelph, Guelph, Ontario N1G 2W1

...AAPT (from page 2)

ply by looking through the glasses as I hold them at arms length. I hesitate to take one students glasses and then have the whole class take turns looking through them as they are passed around the room. I am now in the process of collecting old, used, lost, etc. glasses from optometrists so that I can make this a quick exercise for them without embarrassing anyone and without running the risk of damaging someone's glasses. The diverging lenses used to correct myopia will cause a distant object such as a clock across the room appear smaller when viewed through these glasses as they are held at arms length. The smaller the image the greater the correction required. The converging lenses used to correct hypermetropia also give predictable results. Of most interest are the lenses used to correct astigmatism. If you look at a distant object when you hold these at arms length a distorted image is seen.

This exercise also quickly shows that in most cases the prescription for the left eye is different from the prescription for the right eye.

E-Mail Us!

Some days I feel like the Maytag Repairman.

Drop me a line through the mail, fax, or Internet. Your comments, criticisms, observations are welcome.

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1994 CAP CONGRESS

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I/we plan to stay: ( ) in residence ( ) at the______________ Hotel.

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EVENTS INCLUDED IN THE REGISTRATION FEE. Please check box if applicable:

( ) I will attend the ( ) Plasma Physics / ( ) Condensed Matter Physics Symposium on Sunday, June 26

( ) I will attend the Welcome Reception on Sunday evening, June 26 (refreshments will be served)

REGISTRATION FEE (all prices include GST):		Amount
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OPTIONAL EVENTS NOT INCLUDED IN REGISTRATION FEE

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THE DEMONSTRATION CORNER

Flipping for Physics

by

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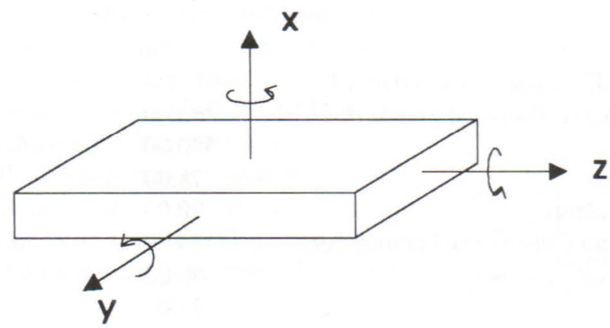
Here is a good demonstration that can be used in its simplest form to show stable and unstable equilibria or, in a more advanced version, to illustrate some finer points about moments of inertia and angular motion. The material needed could not be simpler. You need a board. There are no special requirements here except that the board be rectangular and have three distinctly different dimensions. In a pinch, I have used a good-sized physics text book held closed by a strong elastic. Most brief cases work and if students feel lucky, they can try out their calculators.

The demonstration starts out by showing that a rectangular object has three principal axes (label them x, y, and z) about which it can rotate.



If you are teaching moments of inertia, you might have the students classify these axes by increasing moments. For our purposes, we note that $I_x > I_y > I_z$. Now toss the board up into the air giving it a good spin about the x-axis and have the students note its nice stable rotation. You will have to practice this a bit to give the board enough spin and hang-time for the stability to be evident to the whole class. Do the same for the z-axis and then pick a volunteer from the class and challenge him or her to repeat the trick for the y-axis. A rotation about this axis is unstable and will quickly decompose into a combination of rotations about the other two.

Students are always curious about unstable systems. At the very least, it is worth getting across the concept that an unstable equilibrium will (due to the slightest perturbation from anywhere in the universe) degenerate. Let them try the y-axis spin until they have satisfied themselves of this. The explanation of the effect follows and uses concepts from angular momentum and energy, both of which must be conserved while the object is spinning freely in the air. Conserving energy is the easiest and gives us

$$\frac{1}{2}I_y\omega_0^2=\frac{1}{2}I_x\omega_x^2+\frac{1}{2}I_y\omega_y^2+\frac{1}{2}I_z\omega_z^2.$$

We assume here that the board was given an initial spin about the y-axis with initial angular speed ω_0. We look for a final situation in which the board may be simultaneously spinning about any and all of its principal axes. Since angular momentum is a vector, it is a bit pesky to write its conservation equation directly. It is much easier to write the equation corresponding to the conservation of the square of the angular momentum. This gives

$$I_y^2\omega_0^2 = I_x^2\omega_x^2 + I_y^2\omega_y^2 + I_z^2\omega_z^2.$$

If we multiply the energy equation on both sides by I_y and combine it with the angular momentum equation to eliminate $I_y^2\omega_0^2$, we can arrive at

$$(I_x^2 - I_xI_y)\omega_x^2 = (I_yI_z - I_z^2)\omega_z^2.$$

Since $I_x > I_y > I_z$, both sides are positive and a solution exists for ω_x and ω_z. If we repeat the above calculation to ask for the case where the initial spin was about, say, the x-axis, we find

$$(I_y^2 - I_xI_y)\omega_y^2 = (I_xI_z - I_z^2)\omega_z^2.$$

In this case, the left side must be negative but the right side is positive. The only solution is $\omega_y = \omega_z = 0$. One would find the same thing for an initial spin about the z-axis.

The above analysis does not require that we be studying a rectangular board. Generally, objects spinning about axes corresponding to their greatest and least moments of inertia will be stable whereas a spin about its third axis will be unstable. Objects with enough symmetry to give identical moments of inertia for one or more of their axes do not have any unstable spins. Cubes, cylinders and spheres fall into this category. Imagine the problems if a high-speed flywheel had an unstable rotation about one axis. Satellites are also manufactured to avoid these problems.

On the other hand, some objects are made specifically so that when spun, a complex tumble will result. I have seen at least one amusement park ride incorporate this concept: the one where a rider straps into a seat mounted within two gyroscope-like gimbals. The operator gives the rider an initial spin and physics takes over (with usually a little biology mixed in for good measure).

Column Editor: Ernie McFarland, Physics Dept., University of Guelph, Guelph, Ontario, N1G 2W1

Submissions describing demonstrations will be gladly received by the column editor.