1969

A Glance at the Showmanship of Physics

John E. Savage
Ouachita Baptist University

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Physics 491

by

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A Special Studies Paper

Presented to

Dr. J. W. Patrick

Department of Physics

Ouachita Baptist University

In Fulfillment

of the Requirement for Physics 491

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"Teachers should present dramatic demonstrations of scientific princles and involve students in them. They should dispense fewer facts, ask more questions, and stir the intellect. Then the students will puzzle out the answers and remember them," says Professor Julius Sumner Miller of El Camino College in Southern California. "Remember this! If you're dead, and the text book is dead, you'll have dead students."

The classic example of the intellect being stired by dramatic demonstrations took place in London when Sir Humphrey Davey gave the Christmas Lectures. Beleive it or not, people paid to hear these lectures dealing with natural physical phenomenon and see the dramatic demonstrations which accompanied them. In the crowd of listeners and watchers was an apprenticed printer whose name was Michael Faraday. Yes, the same Faraday who is mentioned in both Physical Science and Physics texts. His intellect, his curiosity, his imagination was sparked and set into motion by the dramatic showmanship of the Christmas Lectures.

"People look, but do not see! They listen, but do not hear! This world is an enchanting place that stimulates all our senses, but most of us ignore it," says Professor Miller.

I became interested in the dramatics of Physics as a high school student. In the first twelve weeks of school we went through three teachers who were more dead than the book. The fourth teacher made Physics alive for us and taught by using various demonstrations and asking searching questions about the commonly known and then proceding to the new by way of comparison. We soon found that it doesn't take a teachers certificate to be a teacher, because at the begining of the second semester he was replaced by a dead but certified Physics teacher.

This high school experience has been accepted as a challenge to use the tactics of the Christmas Lectures, Professor Miller, and my fourth high school Physics teacher in a future classroom of my own. My self set goal is to be a live teacher with students, and hopefuly spark the intellect of another "Faraday".

The purpose of this research has not been to prepare a Physics demonstrarion manual. In the light shed by the Christmas Lectures, Professor Millers statements, and my own high school experience, this research proves only to be a feeble attempt to present some thought provoking questions and dramatic demonstrations of physical, and there by give you A Glance at the Showmanship of Physics.

Q. Why do flags flutter?

A. Air moving past the ripples and folds on one side of the flag reduces the pressure on that side and causes the flag to be pushed in that direction. Now the flag has assumed a new shape, and air moving past on the other side gives rise to the same effect in the opposite direction. Thus the flag flutters![4]

Q. Why does dry snow, or sand at the beach, sometimes squeak when walked on?

A. In part, because the flakes of snow or grains of sand are moved over one another and thus forced into vibration at high frequences.

Q. Why does a baseball curve?[3]

A. A moving stream of air exerts less pressure than air at rest (Bernoulli's principle of areodynamics). Thus the spin imparted by the pitcher reduces the pressure on one side of the ball, making it go in that direction.[3]

Q. How can large potatoes be baked more quickly?

A. Stick one or two ten penny nails into them. Metal is a good conductor, therefore heat is brought to the center of the potatoe more quickly. A WORD OF CAUTION: Be sure to get nails that do not have a cement or grease coating!

Q. How can crying be avoided while cutting onions?

A. Freeze them slightly so that their vapor pressure is reduced.

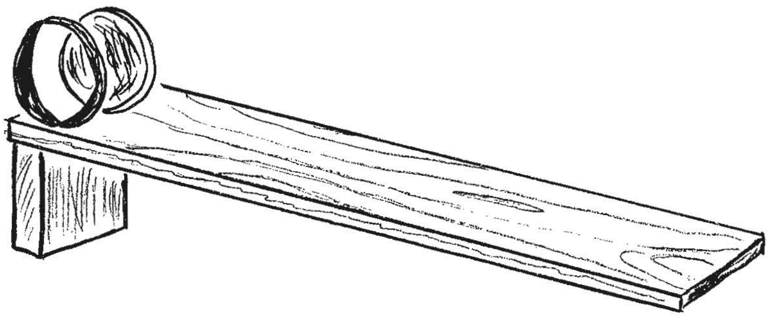
Q. How can you tell if an egg is good or bad?

A. Just grandma used to. Place it in a pan of water, if it floats most likely it is bad. Rotten material in the egg is released through the shell as gas, making the egg light enough to float.[3]

Demonstration: The German physicist Mayer said, "Energy may neither be created nor destroyed." Ask all students who beleive this to raise their hands. Pointing to some student, ask him to come to the front and verify his faith in the laws of Physics. With a pendulum consisting of a lead ball on the end of a long chain, have the student stand with the ball drawn back against his chin. Now release the ball, it will swing back just grazing his chin the first time and then slowly swing to a stop due to the force of gravity acting upon it. That student will never forget the law of the conservation of energy.[4]

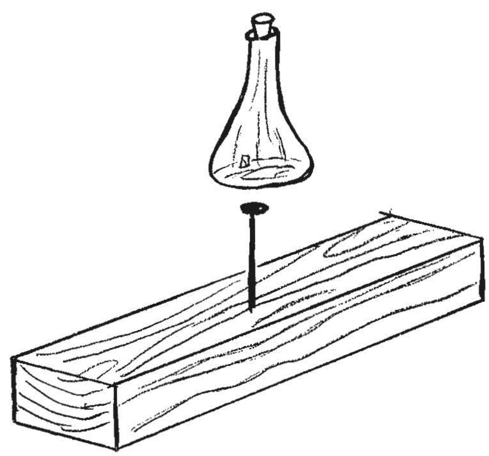
Demonstration: To show that air has weight, use a single folded sheet of newspaper and a wooden slat 4 inches wide, 36 inches long, and ¼ inch thick. Lay the slat on the table with about 4 or 5 inches extending over the edge, then spread the newspaper over the portion on the table. Ask- What will happen if I strike this exposed end? WATCH! Bringing the fist down smartly, the slat breaks leaving the newspaper where it was. "Jack, what does this demonstrate?" If the student answers correctly,autograph the broken end and give it to him. If the newspaper is approximately 23x30 inches, the atmospheric pressure 15 pounds per square inch, then some 10,000 pounds of air were bearing down on the paper which in turn held the covered portion of the slat down.[3]

Demonstration: The question is, do all things roll at the same speed, such as hoops, discs, and spheres? Or does one beat the other? Let's place some bets. Choose your favorite horse for the lecture room derby. (If some show a lack of enthusiasm by not choosing a horse, dismiss them for the day.)



After trying some of all three of different sizes and weights, it can be announced that all spheres will beat all discs, which will beat all hoops. Now that you have seen this demonstrated, if you want to know why, look up Huygens' moments of inerta and Newton's laws of rotation.[4]

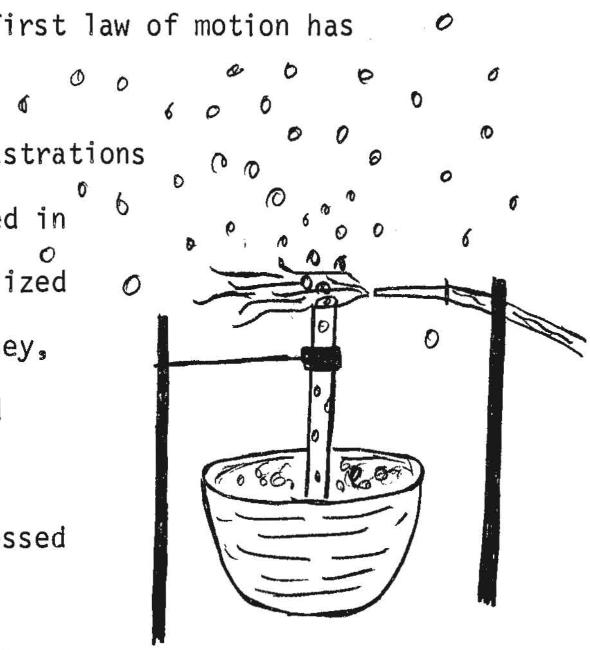
Demonstration: Hold up a flask which has been filled with water and capped, not allowing a single air bubble to remain inside. I can a nail with this! Do you beleive it? Now hammer a three inch nail into a soft piece of pine. Ask a student why this can be done. Because of the incompressibility of water, a principle which Pascal discovered, the glass flask did not break as most students would expect.[4]



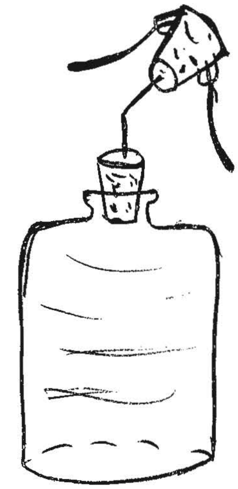
Demonstration: Today we are going to demonstrate something that defies the imagination. We are going to boil water without heat, and then instantly freeze it. Place a saucer of water under a belljar and start the vacuum pump. As the pressure goes down, evaporation will increase. When the pressure in the jar and the vapor pressure of the water become equal, the water will begin to boil. Since evaporation is a cooling process, the temperature of the water falls until-----suddenly the bubbling water changes magicly into ice.[3]

Demonstration: A teacher can use this to show his class he has faith in the laws of Physics. The teacher will lay down on the demonstration desk and up end a fairly large piece of pulp wood on his chest. Then he will point to a husky boy and ask him to come drive a railroad spike into the log with the 16 pound sledgehammer. The inertial mass of the log keeps the blows which should be crushing the teachers chest from hurting him at all. Newton's first law of motion has been proved.[1]

Demonstration: One of the most impressing demonstrations of Bernoulli's Principle can be acomplished in the following manner. Fill a moderately sized bowl with puffed rice, place a glass chimney, about ½ inch in diameter,into the bowl and extend downward to within one inch of the bottom, and then direct a stream of compressed air across the top of the chimney. If someone guesses that the puffed rice will be blown out of the bowl by air going down the chimney, they are wrong. The puffed rice will spew out of the chimney and around the room. This demonstration shows that a moving stream of air exerts less pressure than air at rest.[4]



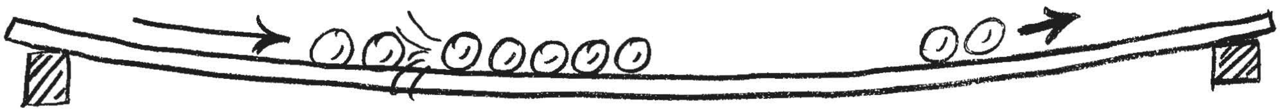
Demonstration: I am about to demonstrate a principle that boat designers have known for years. A system is more stable if the center of gravity is below the point of support. Here are two corks, each with a finishing nail driven into them head first. Can you balance one cork on the other using the nails as the point of contact? NO! Now we will move the center of gravity of one cork by sticking two forks into it with the handles extending past the point of the nail, and the other cork we will place nail up in a bottle. Now, to try the blancing act again. Isn't that marvelous how the two corks are able to be balanced.[1]



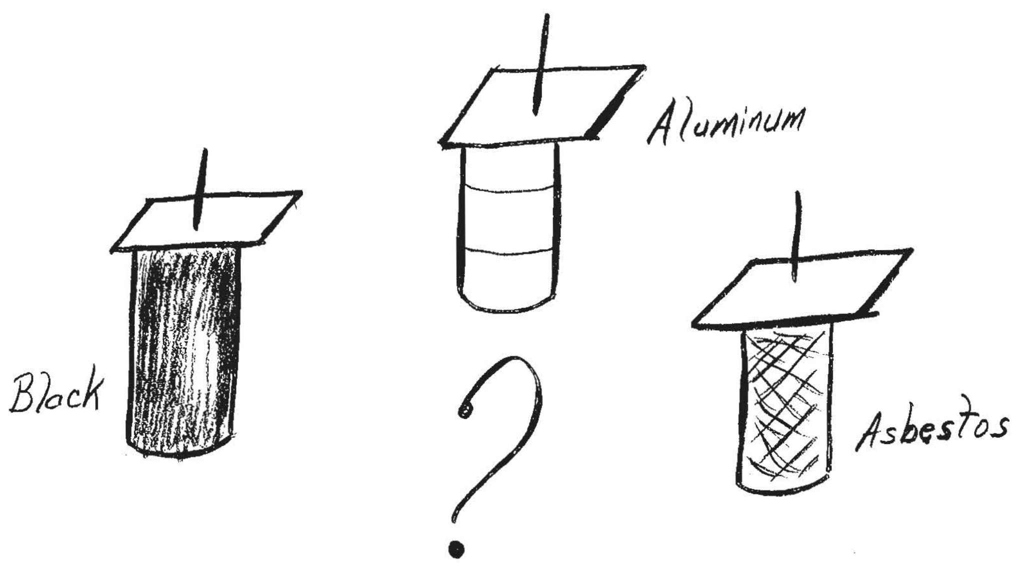
<u>Demonstration</u>: Place a coed on a stool that will spin. Give her a weight for each hand to be held at the arms length with the instructions to pull them into her shoulders when the comand to pull is given. Spin the stool and after its speed has leveled off, shout pull. The coed will rotate faster. When mass is concentrated toward the center, the speed of rotation will increase. If you want to know more, look up Huygens'and Eulers'moments of inerta, and Newton's and Maxwell's laws of the conservation of momentum.[3]

<u>Demonstration</u>: This demonstration might be called the Mystery of the Colliding Spheres. Here on this flexible track are eight uniform steel balls. If ohe is brought up to the end of the track and released, what will happen? It will travel down the incline and gain a velocity V and have a momentum MV (mass x velocity) when it collides with the remaining seven balls. In the collision the momentum will be transfered to the ball on the other end so that it will leave the groupe with avelocity V and a momentum MV.

The question now arises as to what will happen if two balls are released? Will two leave the other end, each having a momentum of MV, or will one leave with a momentum of 2MV since 2V x M = 2MV ? The latter choice is absurd, because energy would have to be gained in the collision. Impossible!! The energy of a system cannot increase of its own accord.[2]

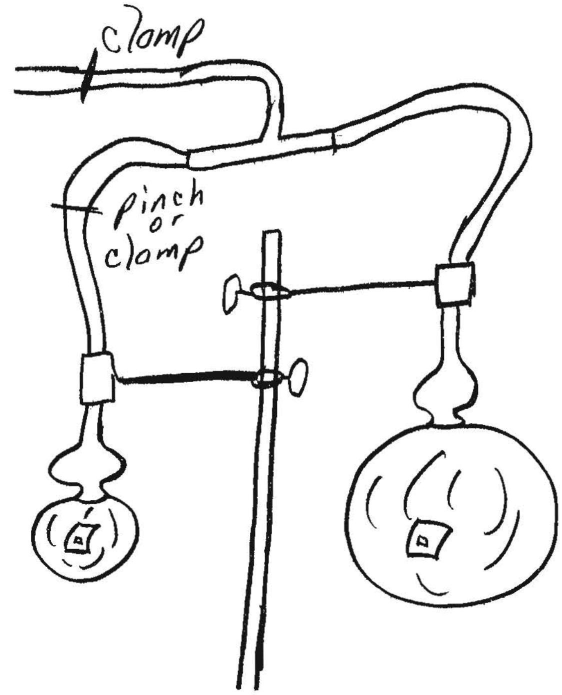


Demonstration: I have three cans that are identical except for their outside coatings. One is sprayed with Aluminum paint, the second with black paint, and the third is covered with a thin layer of asbestos. The question is, if identical masses, weights and volumes of hot water at identical temperatures are placed in each can with identical stoppers and thermometers, which will cool the fastest? Let us take a vote.

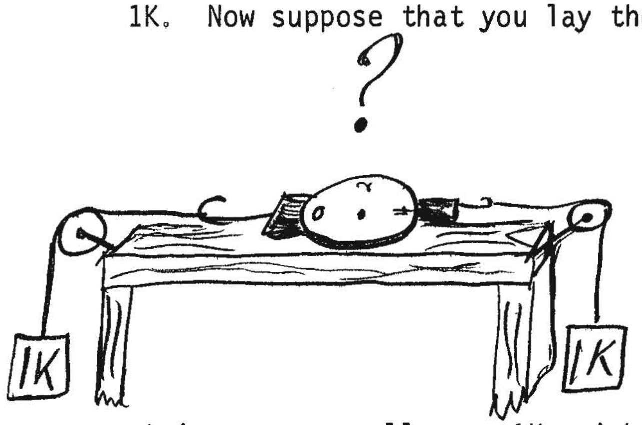


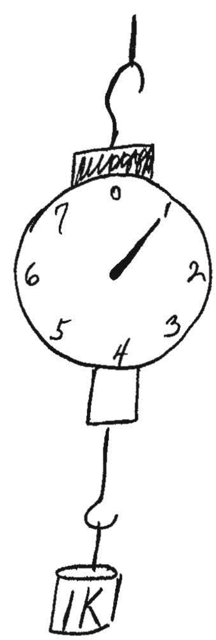
The asbestos covered one! Isn't that unreasonable? When the facts are examined closely, it is found to be quite reasonable. Because of the porous quality of asbestous, the surface is multiplied many times so that it cools the fastest.[2]

Demonstration: Today we will investigate the Double-Bubble Paradox. You see here two common thistle tubes which are connected to a single rubber hose means of a glass T. After I momentarily dip the thistle tubes in a soap solution, I will blow two different sizes of bubbles by pinching the rubber hose to one of the tubes and then seal the system from the outside air by means of a clamp. What will happen if the clamp between the two bubbles so that air could move between the two? So, your guess is that their sizes will equalize. Wrong!! The smaller bubble will get smaller; whats even more amazing is that the smaller it gets, the faster it gets smaller. The smaller bubble gets smaller because the pressure in a bubble is in inverse proportion to its radius. The smaller the bubble, the greater the pressure, and the faster it gets smaller. [2]



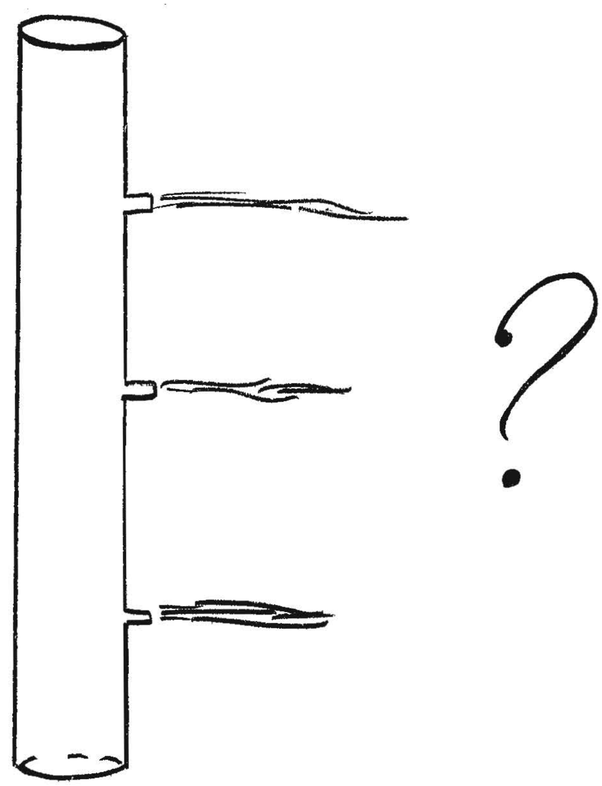
Demonstration: If a 1K weight is weighed on a spring balance, the face reads 1K. Now suppose that you lay the balance on its back and by means of a string over a pulley, a 1K weight is attached to each end of the balance, what will the balance read? Not 0! Nor 2K! Or does it? Think!





It reads 1K. Why? Did you ever stop to consider the fact that in holding the scale to weigh the 1K weight, that you had to exert a 1K force upward to keep from droping it? [2]

Demonstration: By a quick glance you can tell that this is a rather tall and fairly slender can. The can has identical holes at distances of 1/4, 2/4, 3/4 from the bottom of the can. If the can is filled to the top with water and is kept at that level by means of a hose, what will be the relative velocities of the water coming from the three holes? That is an easy question, the top has the least and the bottom has the greatest velocity. Now for the harder question, how do the paths of water come to the table top? What does everybody say? Greatest at the bottom and the least at the top as the predicted ranges, are all agreed? You're all wrong then. Isn't that amazing? Before I show you what happens, I'll tell you something else that's wonderful: the maximum range is equal to the total height of water in the can. Now what will your new prediction be?



It would take 25 to 30 minutes to show you what I am about to say mathematically. Suffice it to say that water spouting from the middle hole has the greatest range! Spouts from the bottom and top holes don't shoot as far, but they have identical ranges. [2]

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[3]Hamilton, Andrew. "Mad, Mad, Mad, Mad Physicist," PTA Magazine, Janurary 1965, pp. 12-14+.

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