NEWTON'S FIRST and THIRD LAWS

(L-5)

Newton's Laws are comprised of three observations about the physical world that seem to govern the interaction of matter and motion. This lab is designed to examine the *first* and *third* of these laws.

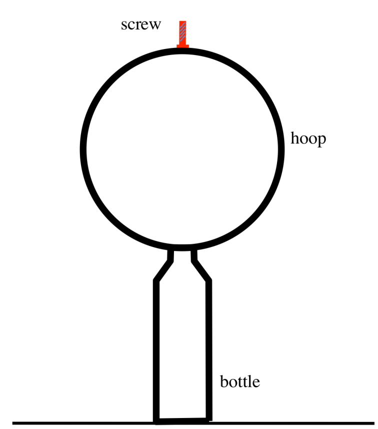
Note: You will be working in teams of TWO and, sometimes, teams of FOUR during this lab. Also, there are questions embedded within each procedure that are designed to help you understand the law being examined in that section. When you have finished a particular section, I may quiz you or your partner to see how well you have understood what you have seen and done. It will be *my choice* as to who I question in your group. As your team will receive a single score for your efforts, I'd suggest you be sure your partner understands the material as well as you do (or vice versa).

PROCEDURE--DATA

Part A: (Newton's First Law)

a.) Newton's First Law states that in an inertial frame of reference (for now, read this *fixed frame of reference*), objects in motion tend to stay in motion in a straight line and objects at rest tend to stay at rest unless impinged upon by an external force.

b.) With that in mind, consider the following: You and your partner will be provided with an embroidery hoop with a small piece of sandpaper glued onto its outside surface, a Coke bottle, and a screw. Place the hoop so that it is balanced over the mouth of the bottle with the sandpaper positioned at the top. Place the screw on the sandpaper. If done correctly, the screw should be positioned so that if it were allowed to drop, it would free fall directly into the bottle (I've placed a mark on the hoop to identify the part of the hoop that should be directly over the bottle's open hole).



c.) The question you must answer (and the task you must demonstrate) is: *without touching anything except the hoop,* how can you get the screw into the bottle? (No, you can't lift the hoop straight up, then try to throw the screw into the hole). Remember, the only thing you can touch is the hoop. Please don't break my hoop in the process!!!

d.) Once you have achieved your goal, decide how N.F.L. fits into this part of the lab. I will feel free to ask anyone in the group questions about the task and its accomplishment. Your grade *as a group* will be determined by how those questions are answered.

Part B: (Newton's Third Law, a board, a little silly putty and two nails)

e.) This part of the lab requires the use of a board with nails at either end. Each partner should also have a piece of silly putty which they have rolled into a ball. Before you start, assign you and your partner a number (i.e., 1 or 2). I will use those numbers in the write-up below.

f.) You and your partner must hold the board in the horizontal so that each partner's palm is pushed up against one of the protruding nails via the silly putty. If there are adjustable straps available on your board, position yours so that it holds the nail snugly against the putty without depressing it.

g.) With the board held horizontally (parallel to the ground), *partner 1* must *gently* push on the nail/boards with *partner 2* remaining stationary. DO THIS GENTLY--YOU ARE NOT TRYING TO HURT ONE ANOTHER! If this doesn't seem possible, *partner 2* may support his or her hand against a wall. After the push, the two of you should compare notes. That is, did both of your putty balls register a force via your nail, or was it only the pusher (*partner 1*) or the passive partner (*partner 2*) that registered the force? Be sure you both understand what is happening before you go on.

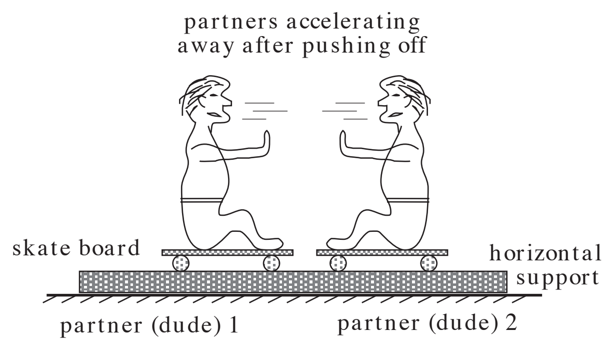
h.) Theater of the Macabre: Let's say there is no putty, so you are holding the board up by placing the nail directly against your palm, and you and your partner are set up to do *Procedure g* with *you* doing the pushing. Suddenly, you have some kind of epiphany and realize that your partner is the one who instigated the break-up between you and your soul mate. Given the set-up (no, you can't disconnect yourself from your nail and pummel your partner), would it be wise to try to extract revenge (assuming it is ever wise to be vengeful) via the nail that is directed into your partner's hand? That is, within the confines of the experiment, would it be a good idea for you to push really hard in an attempt to use your partner's nail to hurt your partner? Put a third way, if you did push hard, what would your nail do to you?

i.) Newton's Third Law is directly related to the little bit of amusement you just play-acted through in the thought experiment you did in *Procedure h*. From your observations having to do with that thought problem (and from your actual experience with the nails), what do you suppose Newton's Third Law states?

j.) For the amusement of it, let's try *Procedure g* again with a twist. There should be two pieces of silly putty with your board. Roll both pieces into a perfect ball. Have each partner place the silly putty between the palm of his or her hand and the nail. What happens when *partner 1* pushes? How do the nail depressions in the silly putty compare? Are they approximately the same? What does this tell you about the force each nail provided to each partner?

<u>Part C</u>: (Newton's Third Law and skateboards)

l.) Pair off with another group so that there are *four* people working together. In doing the pairing, try to make it so that there are two people within the group who are about the same weight, and two people who are disparate (i.e., so that one person is bigger and the other smaller).



m.) Your group will have two skateboards and a relatively flat runway. The two individuals in the group who are approximately the same size should *sit* (DON'T STAND), one on each skateboard, with the remaining two members watching from approximately ten feet away (to get perspective).

n.) The skateboarders should position themselves so that they can push off one another. In that position, skateboard *partner 1* should shove while *partner 2* tries to remain rigid. To a rough approximation, how does the initial velocity and distance traveled compare between the two skateboards after the push (this is what the watchers are suppose to determine through observation)? Don't be anal about this. You are dealing with a very approximate situation (lots of friction, a platform that is probably somewhat tilted, etc.).

o.) Redo *Procedure n* with the roles reversed. Has the relationship observed in *Procedure n* changed, or are you seeing pretty much the same thing?

p.) Redo *Procedure n* with *both* skateboarders gently pushing. Any change in your general observations?

q.) From your observations, what can you say about the magnitude of the force *partner 1* applies to *partner 2* as compared to the magnitude of the force *partner 2* applies to *partner 1*. Be ready to make generalizations.

r.) For the amusement of it, have *partner 1* and *partner 2* clasp hands. See if *partner 1* can motivate his or her skateboard to move *without* moving *partner 2's* skateboard. If *partner 1* tries and can't do it, are you surprised? If *partner 1* CAN do it, explain why.

s.) For one last blast, have *partner 1* and *partner 2* grasp each other's hands and pull and push indiscriminately. What does their motion look like? Be able to explain what you see.

t.) Now with the largest and smallest member of your foursome sitting on the skateboards, have the smaller person push. What happens? Why does it happens as it does?

u.) Redo *Procedure t* with the larger person pushing. Is there any difference from what you observed from *Procedure t*?