NEWTON'S FIRST LAW OF MOTION

PROBLEM PRESENTATION / EXPLORATION

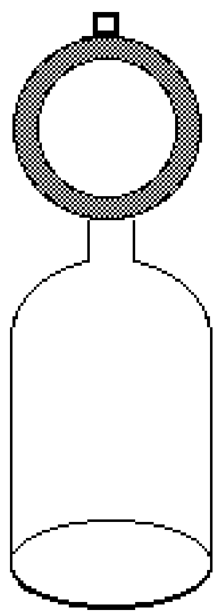
A. How many of you have ever seen a magician pull a tablecloth off a dinner table, complete with dishes, without breaking any of the dishes? Is it really magic, or is it science?

B. Station Setup

1. Each station should be identically equipped with a 12-inch wooden embroidery hoop, a narrow-mouth bottle, and sugar cubes. (A substitute for the embroidery hoop can be made by taking a large cylindrical plastic bottle and with scissors cutting out from the middle of it a hoop about one half inch high having a diameter of about six inches.)
2. Very carefully balance the embroidery hook vertically on the mouth of the bottle. Stack a sugar cube on top of the hoop.
3. The CHALLENGE in this activity will be to get as many sugar cubes as possible into the bottle by hitting the hoop with only one hand. With practice a stack of sugar cubes can be used in place of the single cube.
4. Students at each lab station constitute a team. The winning team is the one who gets the most sugar cubes in the bottle in a given time.

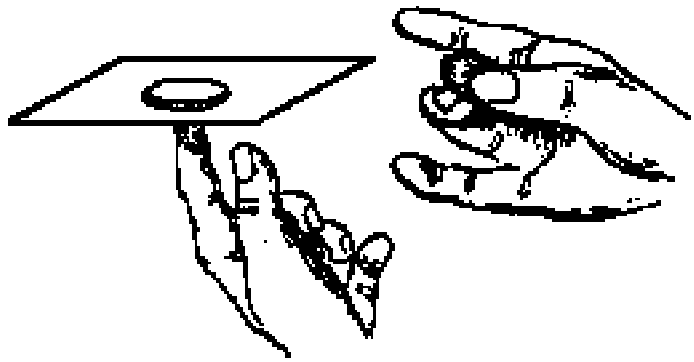
CLASS RESPONSE / CONCEPT INVENTION

A. Have each team report their results and describe the method they used in trying to get the sugar cubes into the bottle. (The best technique will probably be to face the hoop toward you so that you can see the full circle. Swing your arm across your body horizontally, quickly grabbing the far **inside** edge of the hoop while your arm is moving, and flicking your wrist to move the hoop from beneath the sugar cubes. The sugar cube should drop into the bottle.



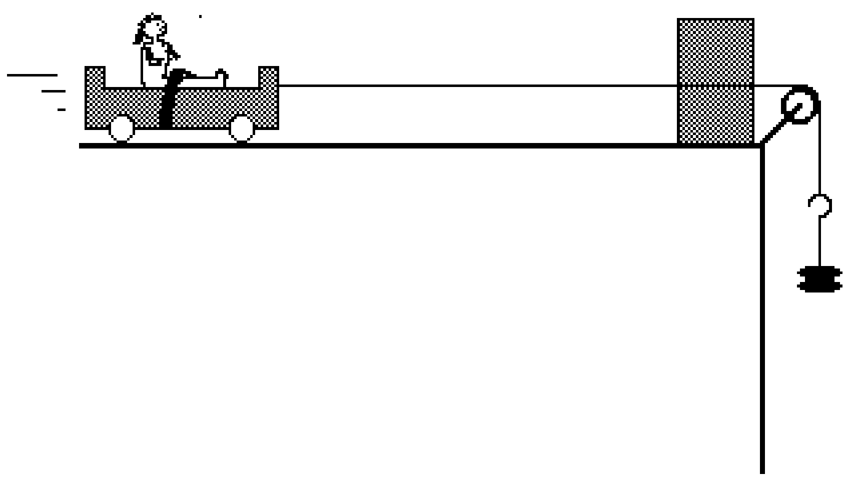
B. Why did the winning group win? What kept the sugar cubes from scattering? (At this point, students may not realize that inertia is involved, but they should come to the conclusion that the hoop moves while the sugar cubes do not, other than to fall into the bottle. As long as the sugar cubes rested on the hoop there were equal forces pushing up and pushing down on them and they didn't move. When, by snatching the hoop away, the upward force exerted by the hoop on the sugar cubes was taken away the sugar cubes experienced an unbalanced force and started to move. When they started moving they continued to move until another force, the bottom of the bottle, acted on them and brought them to a halt.)

C A slightly different example of this is to cut a 3 x 5 card in half, place a penny in the center of the card and balance the card and penny on your left index finger. With your right middle finger flick the card off of your index finger. If you do this so that the card moves in a horizontal plane, the penny should stay on the finger tip. If the removal of the card is not done quickly both the card and the penny will more. The inertia of the penny accounts for it remaining where it started while the card is set in motion.



D. In the next activity, students will be asked to discover the importance of wearing a seat belt.

1. Each station should be identically equipped with a 2 meter piece of string, 1 dynamics cart, a 200-g hook mass, a rubber band, 1 doll (to fit the dynamics cart), 1 pulley, and 1 block of wood.
2. Attach one end of the string to the dynamics cart and the other end to the 200-g mass. Attach the pulley to the end of the lab desk and hang the mass over the pulley so that the mass is on the floor and the cart is on the desk. Place the block of wood on the table in front of the pulley (between the pulley and the cart). Then place Barbie on the cart. Next, pull the cart back and release it so that it accelerates toward the edge of the desk. Observe and record what happens. [Here, Barbie keeps on going when the car stops.]

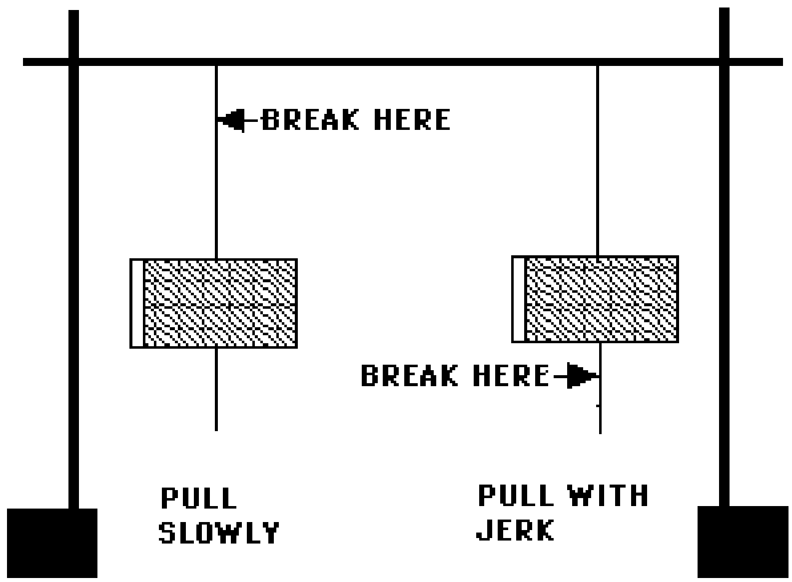


3. Repeat this procedure, but this time, attach the doll to the cart with the rubber band or tape (the seat belt). Again, observe and record what happens to Barbie. [Here, Barbie stops when the car stops.]
4. These experiments illustrate Newton's First Law of Motion and the concept of inertia. Based upon the results of the class, formulate what Newton's First Law of Motion says. [An object at rest remains at rest or an object in motion remains in motion until acted on by an external force.]

CONCEPT EXTENSION

A. Setup

1. Suspend from the ceiling or other horizontal support two pieces of thread about 3 meters long.
2. Wrap the first piece of thread around a paperback book allowing it to hang down.
3. Wrap the second piece of thread around an identical paperback book so that it hangs down an identical distance from the ceiling.
4. Tie another piece of thread around the first book so that it hangs about one meter below the bottom of the book. Both strings tied to the book should be in the same vertical line.
5. Repeat step four on the second book so that there are two identical setups.



B. Prediction

1. Ask the students what will happen when you pull on the bottom thread attached to the first book.
2. If they say the thread will snap above the book, jerk rapidly and the thread below the book will snap.
3. If they say the thread will snap below the book, pull slowly on the thread and the thread above the book will snap.

C. Explanation

1. By pulling the thread slowly, we are not only putting a strain in the thread, but in the thread above the book, the book's weight adds to this pull. Thus compared to the strain below the book, this is much larger and the thread snaps wherever the strain is highest.
2. When a sharp jerk is exerted on the thread, the inertial of the book keeps the strain below the book. Although there is some strain in the thread above the book, compared to that below the book, the strain in the latter is still higher, and the thread snaps below the book.