

Beating Gravity

Ball Fall Down

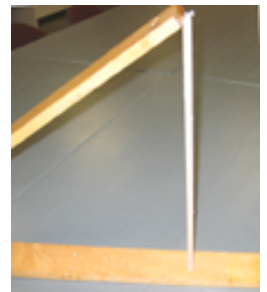
Introduction:

The device you will build is shown at the right. A hinged board has a cup attached a short distance from the free end, and a golf tee mounted at an angle just at the free end. When the free end of the hinged board is raised and supported by a stick, the orientation of the golf tee becomes such that a golf ball will stay perched on it. The top of the cup is then a little higher than the bottom of the ball. When the support stick is knocked away, the cup falls faster than the ball, and the ball falls into the cup.



Materials:

- Golf tee
- Golf ball or other hard small ball
- 2 1x4 cut to the same length of about 3.2 ft. (about a meter)
- 1 piece of wood roughly 3/4 in. by 2.5 ft. (henceforth called “the stick”)
- Plastic cup or other small container
- Door hinge
- Screws for hinge
- Sponge, tissue or other material to soften the fall of the ball
- Finishing nail or pin



Assembly:

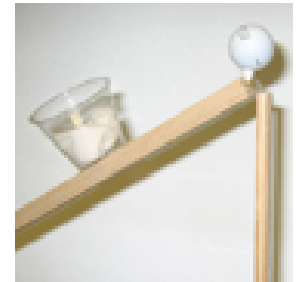
1. Obtain or cut two pieces of wood the same length. These will be the arms of your device.
2. Stack the arms and hinge them together at one end. The two pieces should swing freely.
3. With one arm laying flat on the table, open the other to about 45°.
4. Insert a smooth nail or pin part way in at the end of the upper arm. Insert the pin parallel to the table. This will give the stick something to **support**.
5. Insert the stick between the hinged arms. Rest one end of the stick on the bottom arm and rest the nail on the upper arm on the stick. The stick should be positioned straight up and down (90° with the table). The hinged arms should be able to remain open with out assistance.
6. Mark the location where the stick rests on the bottom arm. This will enable you to set up your apparatus more quickly for each demonstration.
7. Make the ball-holder by drilling and gluing a golf tee into the edge of the upper arm. You may need help drilling this hole and insuring the proper angle. The golf tee needs to point straight up when the hinged arm is open.
8. With the apparatus open, mark the bottom arm directly below the golf tee. This mark needs to be precise. You may want to use a plump-bob type-tool. Place the mark on the edge of the lower arm.
9. With the arms closed, attach a cup or other container in the center of the upper arm. This container will “catch” the ball as it falls. Center and attach the container based on the mark from step 8.
10. Insert soft material into the container to soften the fall of the ball. This will aid in keeping the ball in the container.



To Do and Notice:

Set-up your device:

- a. Open the wooden arms.
- b. Set the stick to support the upper arm.
- c. Place the ball on the tee.



Set the mood for the demonstration:

Although the ball and cup are virtually side-by-side, explain to the class that you can get the ball into the cup without touching the ball or cup.....etc.

To do the demonstration, quickly grab and flick the stick away from out between the arms. As the upper arm falls down, the ball should fall into the cup.

What's Going On?

When an object is falling freely under the influence of gravity alone, it is the center of mass of the object that falls with the gravitational acceleration "g." A falling golf ball is a very straightforward illustration of this.



When the hinged board falls in its circular path, the situation

is more complicated than with the golf ball. It is the **center of percussion** of the rigid hinged board (located about two thirds of the way along the board from the hinged end) that falls with gravitational acceleration "g," rather than the center of mass. The parts of the board past the center of percussion, fall with accelerations greater than "g." Since the cup is past the center of percussion, and is attached to the board, it also falls with acceleration greater than "g." It travels along an arc to a position directly under the golf ball, and is waiting to catch the ball when it arrives.

