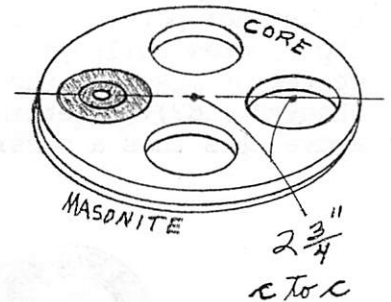


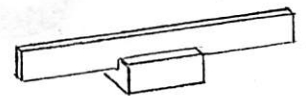
The Darth Vader Disc, or illustrating "The Force from the Dark Side"

The popularity of "Star Wars" is unending; exploit it! This is an old, outstanding demo on "center of mass". The 10" dia. disc is  $\frac{3}{4}$ " thick and has a center of mass that is different from its geometric center. As a result, its behavior seems to defy the usual rules of motion and gravity. The disc has "bullseyes" painted on each side to show the eccentricity or difference in the location of the "centers". Also, a simple device is suggested for tossing, a  $\frac{3}{8}$ " thick, plywood "paddle" with "bullseyes" painted on each side to show the same eccentricity as the disc does.

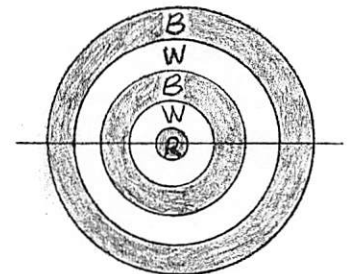
Construction: (a) The disc is a "sandwich" of  $\frac{1}{8}$ " masonite top and bottom discs with a  $\frac{1}{2}$ " plywood disc (core) glued together. The plywood core has four large, 3" dia. holes in it, three empty and one filled with large steel washers. Three 3" OD washers and five  $1\frac{1}{4}$ " OD washers fill the space nicely. This combination of empty holes (mass removed) and washers (mass added) to only one hole, provides the eccentricity needed for the disc to perform well. Cut the three discs on a scroll (jig) saw and cut the four holes in the core on a drill press or a scroll saw. Glue the plywood core and bottom masonite disc first. Add the washers to the one hole; use kleenex to pack the washers in tight so they can't shift (rattle). With a ruler and a pencil, mark a centerline through the "washer" hole out to each edge; mark the edges. Glue the top disc on. From the edges, with a ruler and pencil, draw a light line across the top disc. Carefully sand the edge of the completed disc to remove any high or low spots on the rim so it can roll smoothly.



Make a "knife-edge balance". Any  $\frac{1}{8}$ " thick edge, like a steel ruler, masonite, etc. in a wood block or vise, will do. Place the completed disc with its light pencil line on the knife edge. Does it balance on the edge or is very close? Now rotate the disc  $90^\circ$  and place it on the knife edge again; adjust until the disc balances. Where these two "balance" lines intersect at  $90^\circ$  is the center of mass of the disc. Mark (dent) this clearly on the disc; when you demonstrate, you will need to know exactly where the center of mass is.



(b) Painting the disc on both sides, but not the edge, is highly recommended. Bullseyes on each side add greatly to the explanation of the behavior of the disc in this demonstration.

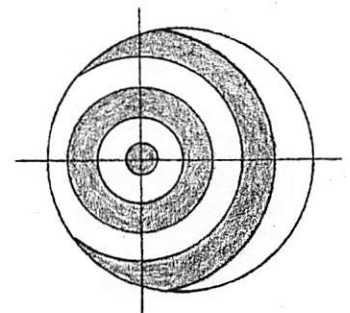


(1) On one side, using the geometric center and a compass, draw a bullseye  $1\frac{1}{4}$ " dia. (painted red), with succeeding concentric circles  $1\frac{1}{4}$ " wide (painted white, black, white, black, etc.).

(2) On the other side, using the center of mass and a compass, draw a bullseye as described in (1) above.

Presentation: (a) On a flat, level surface with the "geometric" side facing the audience, have the disc roll short distances on its edge to the left, then to the right, and then stand still.

(b) Using a slight incline, have the disc roll short distances down the incline and then up the incline. Be careful not to make the incline too steep or the disc will slide rather than roll; work this out before you demonstrate. Now ask the audience to explain what is happening.



Now repeat the demonstration, first (a) and then (b) with the "center of mass" side facing the audience.

Finally, if you are well-coordinated and have practiced, flip the disc (geometric side) straight up, making it spin as rapidly as possible. The bullseye should appear to revolve around another point (the center of mass). Repeat the flip procedure showing the "center of mass" side of the disc. The bullseye should appear to rotate around the center point of the red circle, the center of mass.

(c) The suggested plywood "paddle" with bullseyes painted on both sides derives its eccentricity from its shape, "heavy" vs "light" ends. The smaller or "light" end also serves as a handle when tossing and spinning the paddle. This version can be tossed and caught much more easily and safely either straight up or following a trajectory to another person or catching apparatus (old bedsheet?). Again, as above, draw bullseyes on each side of the paddle, one around the center of mass and the other at some arbitrary point ("center" of the "heavy" end?). Determine its center of mass via the knife-edge method above. (Is this a possible "make-and-take" item and activity?)

