The Bernoulli Effect
(Death Star Edition)

Paul Taylor
Franklin Institute
PTaylor@fi.edu

Science Principle: The Bernoulli effect

Equipment needed:

Toro 51621 Ultra Plus Leaf Blower Vacuum, Variable-Speed (up to 250 mph) with Metal Impeller, 12 amp

Swim Ways Star Wars Death Star Light-up Beach Ball, Classic and XXL Size

25’ Heavy Duty Power Cord

Coghlan's Electric Air Pump

*All items available from Amazon

Procedure:

1. Inflate the small Death Star with your breath or hand pump.
2. Inflate the large Death Star with the air pump. (The leaf blower does not work well for inflation, as the nozzle for the ball is very small.)
3. Plug the leaf blower into the outlet using the 25-foot cord.
4. Turn the adjustable power knob on the blower to about 50% power. (For the smaller ball only.)
5. Have a volunteer hold or throw the ball vertically in the air. Catch the ball in the stream of air.
6. Once stabilized, tilt the ball until you reach a 45-degree angle keeping the ball in the stream of air. If the angle becomes to perpendicular to the floor the ball will fall out of the stream. Practice!
7. For the larger ball follows steps 1-6.
8. Turn he blower knob to full power.
9. Have the volunteer hold the both with both hands over their head.
10. Aim the airflow toward the middle of the ball. Once it begins to lift aim the airflow toward the top of the ball. The ball will begin to spin toward you.
11. See how step of an angle you can achieve before it falls out of the stream of air.

The Science

Okay, it's complicated.

Air is pushy stuff. It never pulls or sucks; it only pushes. Right now, air is pushing on you from every direction about 14.7 psi. This constant push of air is called air pressure. We are so used to air being around us that we don't even notice it. In the 1700's a Swiss mathematician named Daniel Bernoulli discovered that when flowing air or water changed its speed, its pressure also changed. In all of the experiments, the air speed was increased, creating a decrease in pressure, an inverse relationship.

Air traveling close to the ball experiences the Coanda Effect as it passes the curved surface of the ball, which causes the air to travel closely over the ball. The air closest to the ball is traveling faster and has lower pressure. The air further from the center of the ball is traveling slower and has a higher pressure. As pressure always moves from high to low, when the ball tries to slip out of the stream the higher pressure pushes it toward the lower pressure closest to the ball. Eventually the pull of gravity is greater than the pull of the difference of air pressure around the ball and it falls.