# Discovering the Magnus Effect by Rolling Spheres through Resistant Fluids

Gilbert-Snyder, Gwendolyn

My project was to determine the effects of resistance on the trajectories of marbles and the difference between motions ideally and with resistance. I constructed a ramp that could be adjusted to different angles and that ended at the edge of a large tub. A marble was rolled down the ramp multiple times at each angle (15˚, 30˚, 45˚) and I used a camera with the lens open for several seconds to get a picture of the trajectory. I also took pictures while the marble's trajectory was being illuminated with a strobe light, so that the picture would show individual points in the marble's path that could be translated into data points. The experiment was repeated with the tub filled with water to increase the resistance. The results for the experiment taking place in air were as expected—the trajectory had the same general shape of a parabola (but compressed compared to the ideal trajectory) for all three angles, but the compression was greater for the smaller angles. Underwater, however, the trajectories curved backwards so far that the marbles, initially moving to the right, hit the bottom of the tub (30 cm below the surface of the water) to the left of their entrance point. The trajectories underwater were nearly uniform for all angles. The effect of resistance in air was simply the slight compression of the parabolic trajectory, resulting in the marble not traveling as far as it would ideally. In water, the extreme curvature was due to the Magnus Effect, a result of the marbles' spin causing different relative velocities on each side. This difference in velocities caused high and low pressure regions on either side that simultaneously pushed and pulled the marbles in a direction perpendicular to their direction of motion, resulting in a more curved path through the water.