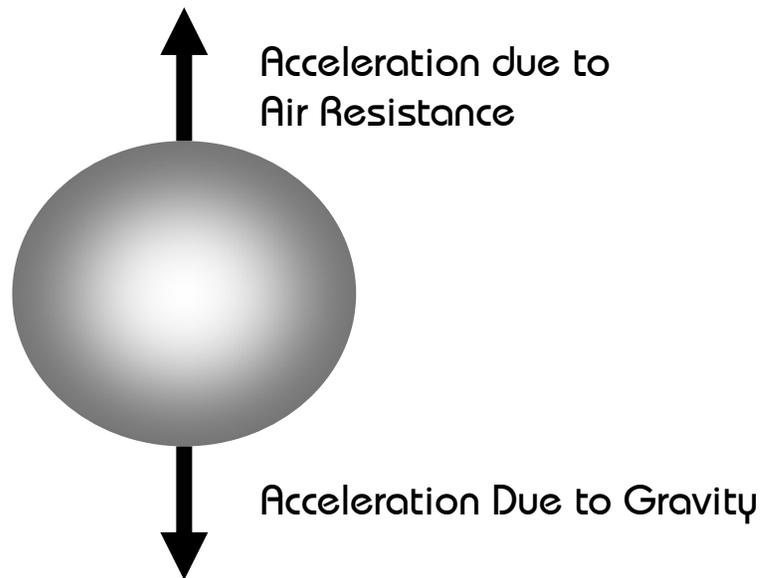


PHSC Lab: Air Resistance

Whenever the surfaces of two objects rub together, a friction force is generated that acts on both objects and opposes their relative motion. This is true even if one (or both) of the objects is a fluid (a gas or liquid, such as air or water). When the fluid in question is air, the friction force generated is called air resistance or wind resistance.

How does friction, and in particular, air resistance work? Well, nobody really knows - it is an active and important area of research. Friction forces in general, and air resistance forces in particular, are very complex. We do know that it is impossible to make simple, accurate, theoretical statements about air resistance. On the other hand, there are 4 properties we do know about:

- the **relative velocity** of the object and the fluid. The word "relative" is important here - as far as the force is concerned, it doesn't matter if the object is moving and the air (or other fluid) is at rest, or if the air is moving and the object is at rest, or whatever. The relationship between air resistance force and velocity is not simple, but certainly more velocity means more force. For very small objects - microscopic to dust mote size - air resistance force is approximately proportional to velocity. For larger, human-scale objects, like baseballs, cars, and people, the air resistance force is approximately proportional to the square of the velocity. In other words, twice the velocity produces four times the force.
- the **shape** of the object. A larger object must push more air (or other fluid) out of the way in order to move through it, so a larger area means more air (fluid) resistance. This is why fast cars and airplanes need to be streamlined. The exact relationship between shape and air resistance force is difficult to predict, however. A shape that one would think would be very effective in reducing air resistance often proves, in practice, to act just the opposite. Even today, a great deal of wind-tunnel testing and redesigning is necessary to effectively streamline an object.
- the **density** of the fluid. Two identical objects moving at the same speed will encounter different resistance forces in different fluids. Dropping a rock through air and dropping the same rock through water certainly produce different motions. Generally, the more dense the fluid, the more resistance force on the object.
- The **mass of the object**. The greater the mass the less effect air resistance has.



In this lab, the goal is to measure the effect that mass has on the acceleration due to air resistance. The steps to follow are:

- 1) Measure the acceleration of the beach ball when it is dropped using the computer to plot a graph of velocity .vs. time. The acceleration is the slope of the line. You will need to do this 4 times so you can take the average of the acceleration.
- 2) Measure the mass of the beach ball in grams.
- 3) Place about 10 g on the beach ball and repeat steps 1 and 2. Do this 4 times increasing the mass each time.

Run	Acceleration 1	Acceleration 2	Acceleration 3	Acceleration 4	Average acceleration
Mass 1 _____g					
Mass 2 _____g					
Mass 3 _____g					
Mass 4 _____g					

Graph the mass of the beach ball versus the average acceleration. Describe what the graphs look like.