Lab #4
Air Resistance

Objectives

After completing this lab, you will be able to:

1. Measure the acceleration of an object dropped from the ceiling.
2. Prove the mass dependence of air resistance.
3. Prove the area dependence of air resistance.

Introduction

When you solve physics problems involving free fall, often you are told to ignore air resistance and to assume the acceleration is constant and unending. In the real world, because of air resistance, objects do not fall indefinitely with constant acceleration. One way to see this is by comparing the fall of a baseball and a sheet of paper when dropped from the same height. The baseball is still accelerating when it hits the floor. Air has a much greater effect on the motion of the paper than it does on the motion of the baseball. The paper does not accelerate very long before air resistance reduces the acceleration so that it moves at an almost constant velocity. When an object is falling with a constant velocity, we prefer to use the term *terminal velocity*, or v_T. The paper reaches terminal velocity very quickly, but on a short drop to the floor, the baseball does not. Air resistance is sometimes referred to as a *drag force*.

Theory

The affect of air resistance depends upon three things: the mass of the object, the size (area) of the object and the speed of the object.

The more massive an object the less affect air resistance has. The more massive an object is the easier it is for the object to push air molecules out of the way. The less massive an object the harder it will be to push air molecules out of the way and the slower it will accelerate due to gravity.

The larger the area the more air an object has to push out of the way and the more effect air resistance will have. The area we are considering is the cross section area of the object (the area you would see looking up at the object). A good example of this would be a parachute, which because of it large area will slow down the fall of a person.

Lastly, the faster an object moves the more air it has to push out of the way, which means that there is more air resistance. When an object is dropped, it starts to accelerate due to gravity, but as it speeds up air resistance starts to increase (due to the increase in speed). The air resistance will increase until the push upwards equals the pull downwards due to gravity. At this point, the net acceleration of the object is zero and the speed remains constant called the terminal velocity.

Apparatus:

1. Balloon	2. Sand
3. Meter Stick	4. Lab Stool
5. String	6. Computer with Interface

Procedure:

Part A

1) Measure the acceleration of the balloon 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 3 times so you can take the average of the acceleration.
2) Measure the mass of the balloon in grams.
3) Using the acceleration due to gravity (9.8 m/s^2) and the result of step 1 to calculate the acceleration of the balloon upwards due to air resistance by subtracting the measured acceleration from the acceleration due to gravity.
4) Place about 20 g of sand in the balloon and repeat steps 1-3. Do this 4 times increasing the mass each time.
5) Use your data to Graph the acceleration due to air resistance versus mass.

Part B

1) With about 20 g of sand in the balloon blow up the balloon as big as possible (without braking it). Using a string looped around the balloon measure the circumference (C) of the balloon. Using:

$$A = \frac{C^2}{4p}$$

calculate the area (A) of the balloon.

2) Drop the balloon and calculate the acceleration due to air resistance as above three times.
3) Let some air out and repeat steps 1 and 2 three times.
4) Use your data to Graph the acceleration due to air resistance versus area.

Data:

Part A: Keep the size of the balloon the same but increasing the mass for each run.

Run	Acceleration due to air resistance 1	Acceleration due to air resistance 2	Acceleration due to air resistance 3	Average acceleration due to air resistance
Mass 1_____g				
Mass 2 _____g				
Mass 3 _____g				
Mass 4 _____g				

Part B: Keep the mass constant and decrease the size of the balloon each time.

Run	Acceleration due to air resistance 1	Acceleration due to air resistance 2	Acceleration due to air resistance 3	Average acceleration due to air resistance
Area 1 _____cm^2				
Area 2 _____cm^2				
Area 3 _____cm^2				
Area 4 _____cm^2				
Mass of balloon _____g				