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Subject: Determine the drag force of a home-made parachute.

Introduction

The goal of this experiment is to calculate the drag force of a homemade parachute. Drag is the resisting force that an item experiences when travelling through a fluid such as air or water. Drag remains constant as altitude increases, this assumes that the reference length and velocity remain constant. The drag force of a parachute is calculated via.

$$F_D = \frac{1}{2} c_D \rho A V^2 \quad (1)$$

where c_D is the drag coefficient of the parachute, ρ is the air density, A is the parachute area and V is the velocity. But because of atmosphere, the velocity will become constant and that velocity is called terminal velocity. To analyze the measured data and determine the terminal velocity, a free body diagram must be created. At terminal velocity, the weight force and drag force of the setup are equal. Then the drag force is calculated via:

$$\Sigma F_y = 0 \quad (2)$$

$$F_D = mg \quad (3)$$

where m is mass and g is gravity constant. We can also calculate velocity using:

$$V = h/t \quad (4)$$

where h is height and t is time.

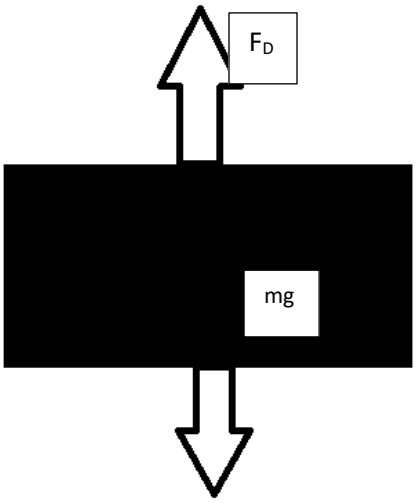

Figure 1. Free Body Diagram of the Setup

The parachute was made out of a plastic bag which was then attached to a load using strings. The load was a small F-22 model made out of rubber.

Procedure

To determine the drag force, the parachute was dropped from different heights. We dropped the parachute from 2 different heights, and we dropped it 3 times from the same height. After recording the time for each drop, the average time for each height was computed. The mass of the model was 18.5 grams and with the parachute was 21.6 grams. There was an uncertainty of 0.01 grams when calculated both the values. The data needed for calculations are.

- Air density- 1.225 kg/m^3
- Gravity constant – 9.81 m/s^2
- Drag coefficient of the parachute- 1.75
- Area of the parachute – 0.04 m^2

The materials used in this experiment were a model, string, plastic bag, stopwatch, camera and measuring tape.

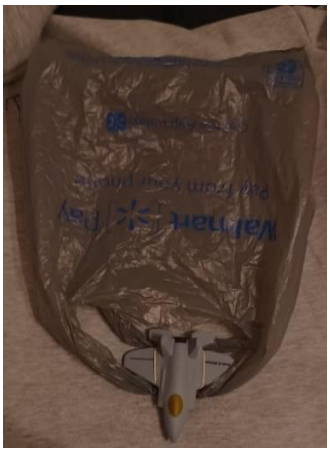

Figure 2. Picture of the setup

Experimental Drag:

$$F_D = 9.81 * 0.0216 * kg * \frac{m}{s^2} = 0.21\ N \quad (5)$$

Results

Table 1. Height and Time					
Trial	Mass (g)	Height (in)	Height (m)	Time (sec)	Velocity(m/sec)
1	21.6	106.8	2.71	1.23	2.20
2	21.6	106.8	2.71	1.18	2.30
3	21.6	106.8	2.71	1.25	2.17
4	21.6	138.2	3.51	1.71	2.05
5	21.6	138.2	3.51	1.68	2.09
6	21.6	138.2	3.51	1.66	2.15

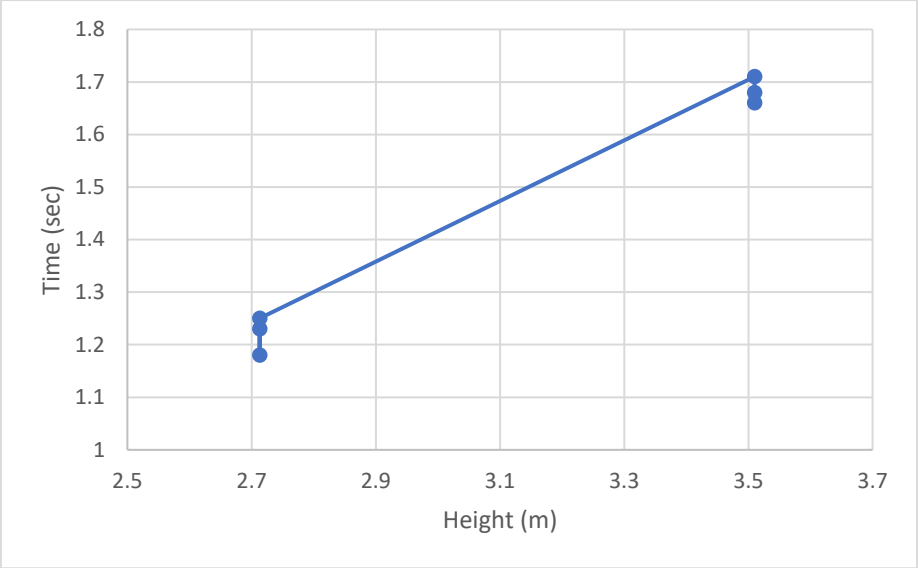

Figure 3. Graph of Height v/s Time

Table 2. Height, Mean Time, and Mean Velocity		
Height (m)	Mean Time (sec)	Mean velocity(m/sec)
2.71	1.22	2.22
2.71	1.68	2.10

Table 3. Calculating the Drag Force					
Height (m)	Mean Time (sec)	Mass of setup (kg)	Gravity Constant (m/s^2)	Experimental Drag Force (N)	Theoretical Drag Force (N)
2.71	1.22	0.0216	9.81	0.21	0.16
3.51	1.68	0.0216	9.81	0.21	0.1

The table 3 presents data on heights, their effect on mean time per height. The drag force is calculated from a free body diagram where weight force is equal to the drag force. We can see that Experimental Drag force is same different heights when reaching terminal velocity which means that drag force doesn't depend from which height you drop the setup. For Theoretical Drag, values are different because the setup wasn't able to reach its terminal velocity in the given time period.

While performing the experiment the wind in the horizontal direction increased the time it took to land. This could be avoided by doing the experiment indoors or in a controlled environment.

Conclusion

The purpose of the experiment was to find the drag force of the homemade parachute. The experimental drag force was calculated by constructing a free body diagram. The experimental Drag force equals to weight of the setup at terminal velocity and was determined using the mass of the setup and the gravitational constant, resulting in a constant value for different height. The experimental drag force came out to be 0.21 N. To get a more accurate value of Drag Force we would given a way to drop the setup from a very high altitude. The difficulty we faced was while measuring time, we used a stopwatch and camera to record the drop. The camera used was a phone camera that doesn't record in high frame rates which led to some uncertainty while measuring time. This could be eliminated by using a camera that records at higher frame rates.