Integrated Science Name:______________________________ Period______

Gravity & Air Resistance Lab

BACKGROUND: A force is any push or pull that one object exerts on another. An object's motion – change in position with respect to time – is influenced by forces. Several forces act on the motion of falling objects, such as a twirling toy.

Objects fall toward Earth at the same rate regardless of size, shape, or mass due to the force of gravity (in a vacuum). The vacuum, or absence of air, eliminates drag, which is created by the force of friction between the object and air. However, we do not live within a vacuum, so it appears that objects fall at different rates. The reason a hammer falls faster in air than a feather is because of air resistance. Air resistance acts in the direction opposite to that of the object's motion; in this case, it acts against gravity. Air resistance is influenced by the object's size, speed, and shape. Air resistance tends to increase the descent time of lighter objects or objects with more surface area more than heavier objects or objects with less surface area.

A twirling toy will spin as it falls because air is being pushed out of the way. As the toy falls, air pushes the rotor (blades) up in a slanted position. The slanted rotors come into contact with air in a vertical and horizontal direction. The vertical air maintains the slanted position of the rotors and slows the twirling toy's descent. The horizontal air pushes on the base directly under each rotor in opposite directions causing the twirling toy to spin. As the twirling toy spins faster, less air flows past the rotors and the descent slows. In this activity, several twirling toy models will be investigated to learn which variables are most influential in the twirling toy's descent.

PRE-LAB QUESTIONS

1. If a feather and a marble are dropped at the same time form the same height, explain which object would hit the floor first based on air resistance? Explain your reasoning.

2. Describe how air resistance would benefit a maple seed like the one shown below.

3. Identify and explain two variables that may affect the descent time of a twirling toy.

PROCEDURE

Part A:

1. Obtains the twirling toy templates. Using scissors, cut out each template along the solid lines and fold along the dashed lines.
2. When you are done making your twirling toy, make sure you have two paper clips, a timer, your twirling toys, data sheet, and writing tool ready.
3. Give each group member their job within the group (1) dropper (2) timer (3) observer.
4. The dropper will be at the top of the drop site with the twirling toys and paper clips. The timer and observe stand at the bottom of the drop site with the target. (Place the target below the extended arm of the dropper with the twirling toy.
5. Follow the data table on the Investigating a Twirling Toy worksheet for variables to test.
6. The dropper releases the twirling toy and say "go". Start timing immediately. Stop the timer when the twirling toy hits the ground.
7. Record the number of seconds it takes for the twirling toy to reach the floor (time in descent) in the data table.
8. Also record:
    a. If the toy hit the target.
    b. Pathway: does the toy fall straight down, in a wavy pattern or erratically?
    c. Stability: does the toy stay vertical (upright) when falling or not?
9. Repeat steps 5-7 for a total of three trials.

Part B:

10. To determine the relationship between mass and time of descent for the twirling toys, we will add paper clips. Follow steps 5-7 with each twirling toy and adding different amounts of paper clips.
11. Fill out the following data tables. *Determine average by adding together the values and dividing by three trials.

Twirling Toy Variables	Average Time of Descent (s)		Twirling Toy Variables	Average Time of Descent (s)		Twirling Toy Variables	Average Time of Descent (s)
Short Rotors 0 Paperclip			Long Rotors 0 paperclip			Rounded Rotors 0 paperclip	
Short Rotors 1 Paperclip			Long Rotors 1 Paperclip			Rounded Rotors 1 Paperclip	
Short Rotors 2 Paperclips			Long Rotors 2 Paperclips			Rounded Rotors 2 Paperclip	

POST-LAB QUESTIONS

Part A:

1. Which twirling toy design has the slowest descent (longest flight time)? Explain which factors helped slow the toy's descent.

2. Which twirling toy design has the fastest descent (shortest flight time)? Explain which factors caused such a fast descent?

3. Did the twirling toy design with the slowest descent have the straightest path and best stability? If not, explain its path and stability.

Part B:

4. What effect, if any, did adding paper clips to the toy have on the (1) time of descent, (2) flight path, and (3) stability?

5. What factors other than the ones tested, might affect the flight time and stability of the twirling toy?

6. If you had to create a design a twirling toy capable of landing on a target with the longest flight time, what would your design have/look like (you may draw & label). Explain your reasoning behind the design.