AEROLAB: Speed & Variables

Background: When conducting experiments, one needs to deal with *variables*, those factors or elements that are likely to vary or change. A typical study has an *independent variable* and a *dependent variable*.

The independent (or manipulated) variable is something that the experimenter purposely changes or varies over the course of the investigation. For example, s/he might change the position of the wing to see how it affects the average speed of a model plane.

The dependent (or responding) variable is the one that is observed and likely changes in response to the independent variable. In the example above, the average speed of the plane is the dependent variable because it is expected to change as a result of moving the position of the wing.

When conducting an experiment, all other variables must be kept the same throughout the investigation; they should be *controlled*. The variables that are not changed are called *controlled variables*.

EXTREMELY IMPORTANT – READ BEFORE YOU BEGIN!!!

Building: On occasion, the Jetstream fuselage is smaller than the housing on the motor hook. If the motor is loose, the motor will wobble when running, resulting in an erratic flight. To be safe we suggest that you shim the motor with a small piece of scrap balsa to ensure a tight fit.

***Winding*:** Lessons featuring the Jetstream are conducted using 1000 turns on the motor (200 rotations of a 5:1 winder). Three *very important* things need to happen to avoid prematurely breaking rubber motors:

- First, all motors *must be lubricated* with *Armor-All* or *Sun-of-a-Gun*; an un-lubricated motor will overheat during winding, causing the motor to break prematurely.
- *Second, you must pre-stretch your rubber motor.* If you do not stretch your motor before testing, you may notice that flight times will increase for each succeeding trial- thereby affecting your data.
- Third, it is very important that you first determine what type of winder you have – a 5:1, 10:1, etc.
- Fourth, when you wind a motor, it is *imperative* that you begin moving in towards the motor hook between 600 and 700 turns (120 to 140 rotations of a 5:1 winder); doing so relieves the stress on the motor as the final turns are added.
- Fifth, make sure you position the winder, the rubber motor and the fuselage of the plane in a straight line, along the same axis; winding a rubber motor at an angle also over-stresses the motor. In summary, motors must be lubricated and wound properly to avoid premature breakage.

***Flying*:** Problems with Jetstream launch most often occur when the plane is not pointed slightly outward, away from the pylon.

- The tether should be tight, the propeller released first, followed by release of the plane. If the plane lacks power, shorten the rubber motor.
- Another cause of an erratic flight is an improper positional of the wing of the plane. After each flight, double check to make sure that the wing is properly positioned.

Timing: When timing the Jetstream, say "time" as the plane lifts off the floor. The liftoff point is lap "zero".

Additional Notes:

PART 1

You will be designing an experiment to see what factors affect the average speed of a *JETSTREAM*. Work with your partners and answer the questions below. One lab report will be turned in for each group. Make sure that the names of each group member are recorded on the outside of the sheets.

1. What factors may increase or decrease the average speed of your *JETSTREAM*? List a few ideas:

2. We plan to investigate/change the following variables:

3. We plan to keep the following variables the same throughout our investigation:

4. Calculate the distance your plane will fly around the pylon:

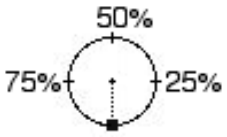
   The radius from the pylon to the fuselage = _____ meters

   One revolution = Circumference = $2\pi r$ = _____ meters

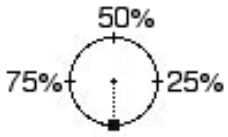
5. After winding your plane 1000 times, release it and note the exact point of takeoff. Record the takeoff point on each circle below. (The release point of the plane is represented by the dot at the bottom of the circle.) Meanwhile, have another person in your group time how many seconds the plane flies in the air around the pylon while a third person counts the laps in the air. Stop timing and counting laps the instant the wheels of the plane touch down. **Wind the rubber motor of the plane the same number of times for each trial.**

6. Record your additional data in the table below:

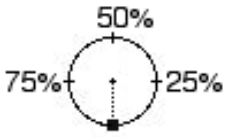
LAPS AND FLIGHT TIME OF THE JETSTREAM			
Trial 1	**Trial 2**	**Trial 3**	**Averages**
Laps =	Laps =	Laps =	Average Laps =
Seconds =	Seconds =	Seconds =	Average Seconds =



Takeoff = _____ %



Takeoff = _____ %



Takeoff = _____ %

7. Calculate the average speed of your JETSTREAM.

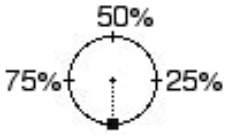
8. Perform at least three trials until you get a somewhat consistent speed for your JETSREAM. Record your data in the table and be sure to show your calculations.

PART 2

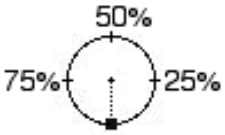
Design an experiment in which you will investigate factors that you believe will change the speed of your plane, i.e., drag, weight, center of gravity, etc. You may choose one variable and change it two ways, or you may test two different variables. Make sure you perform at least three trials for each test.

9. Identify the first variable and record your data from the test of the first variable in the table below:

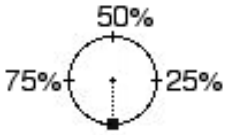
VARIABLE 1: _____			
Trial 1	**Trial 2**	**Trial 3**	**Averages**
Laps =	Laps =	Laps =	Average Laps =
Seconds =	Seconds =	Seconds =	Average Seconds =



Takeoff = _____ %



Takeoff = _____ %

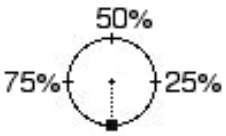


Takeoff = _____ %

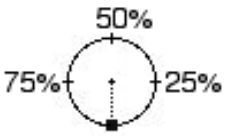
10. Calculate the average speed of your JETSTREAM from the tests of the first variable

11. Identify the second variable and record your data from the test of the second variable in the table below:

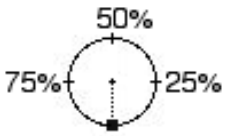
VARIABLE 2: _____			
Trial 1	**Trial 2**	**Trial 3**	**Averages**
Laps =	Laps =	Laps =	Average Laps =
Seconds =	Seconds =	Seconds =	Average Seconds =



Takeoff = _____ %



Takeoff = _____ %



Takeoff = _____ %

12. Calculate the average speed of your JETSTREAM from the tests of the second variable.

13. **CONCLUSION**: Use BOTH Bernoulli's Principle and Newton's laws to explain how the variables you chose changed the speed and flight of your plane. Attach an additional sheet of paper to record your answer.