AEROLAB

DRAG

Name _____ Class Period _____

Background: When you wind up the rubber motor of a model plane, you are storing potential energy. This energy is transformed into kinetic energy when you launch the plane. Drag, the resistance to forward motion, is a by-product of the plane's passage through the air, and it slows the plane down. Adding yarn to a plane increases drag. If yarn is added to a plane (but thrust remains the same) the plane will accelerate more slowly, thereby delaying takeoff according to Newton's 2nd Law, F=MA. As thrust accelerates the plane forward, the wings of the plane generate lift. Both lift and drag are proportional to speed squared. Drag increases until it equals thrust, causing the plane to fly at a constant speed. When the plane flies level and at constant speed, weight equals lift and drag equals thrust. Drag limits the speed of a plane. In general, planes with more drag need more thrust to fly.

Directions: You will be adding yarn to your plane to study how the increased drag affects flight. Work with your partner or group and choose one plane to study.

1) Finish this hypothesis: If drag increases, then… _____

2-4) List at least three variables you should keep the same every time you test your plane.

5) The radius from the pylon to the fuselage = _____ meters

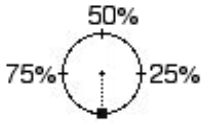
6) One revolution = Circumference = [ ] = _____ meters

7) Fly your *JETSTSREAM* without added yarn.

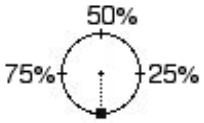
- Adjust the wing to balance the plane. Then mark the wing position with a pen.
- Wind your motor 1000 times with a winder.

- Release your plane 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.

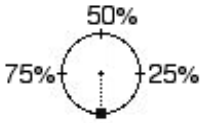
UNMODIFIED JETSTREAM			
Trial 1	**Trial 2**	**Trial 3**	**Averages**
Laps =	Laps =	Laps =	Average Laps =
Seconds =	Seconds =	Seconds =	Average Seconds =



Takeoff = ___ %



Takeoff = ___ %

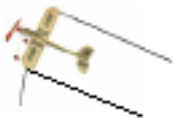


Takeoff = ___ %

8) Calculate the average speed of your *JETSTREAM*.

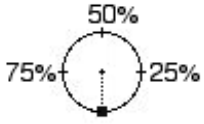
Average Speed = $\frac{\text{Distance}}{\text{Time}}$ = $\frac{(\text{Average Laps x Circumference})}{\text{Average Seconds}}$ = _____ m/sec

9) Fly your *JETSTREAM* with added drag.

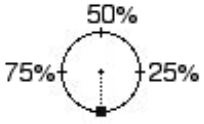


- Attach 50 – 80 cm of yarn to the tip of each wing. Adjust your wing so that it is back at the marked location. Collect data using the same procedure as before.

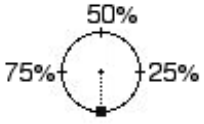
JETSTREAM WITH ADDED YARN			
Trial 1	**Trial 2**	**Trial 3**	**Averages**
Laps =	Laps =	Laps =	Average Laps =
Seconds =	Seconds =	Seconds =	Average Seconds =



Takeoff = ___ %



Takeoff = ___ %



Takeoff = ___ %

10) Calculate the average speed of your *JETSTREAM* with added drag.

Average Speed = Distance / Time = (Average Laps x Circumference) / Average Seconds = _____ m/sec

11) What do the data show? **Summarize.**

12) _____ Which plane seemed to fly at a slower speed?
A) The plane **without yarn** was slower.
B) B) The plane **with yarn** was slower

13) _____ Which plane seemed to climb to a higher altitude?
A) The plane **without yarn** climbed to a higher altitude.
B) The plane **with yarn** climbed to a higher altitude.

14) _____ In addition to increasing drag, what other variable is changed when yarn is added to the plane?

15) _____You may have "flown" your hand out of a car window at fast and slow speeds. Use your experience to answer this question: What happens to ***lift*** when the car (or an airplane) slows down?

I) Lift **Increases** as the car (or plane) slows down
D) Lift **Decreases** as the car (or plane) slows down

16) How did the addition of yarn affect the takeoff distance?

17) Was the *potential energy* of your plane changed when yarn was added to it? Why or why not?

18-20) Why did the plane with yarn behave the way it did? Discuss the relationship between the plane's drag and speed. Also discuss what happens to the lift when yarn is added.