

# Lab: Laws of Motion, Forces, & Paper Airplanes

## Background/Tips:

NFL: Objects will stay stopped or in motion until a force acts on them.  
ex: Force of your hand makes plane go forward.  
Force of gravity points it to the ground.

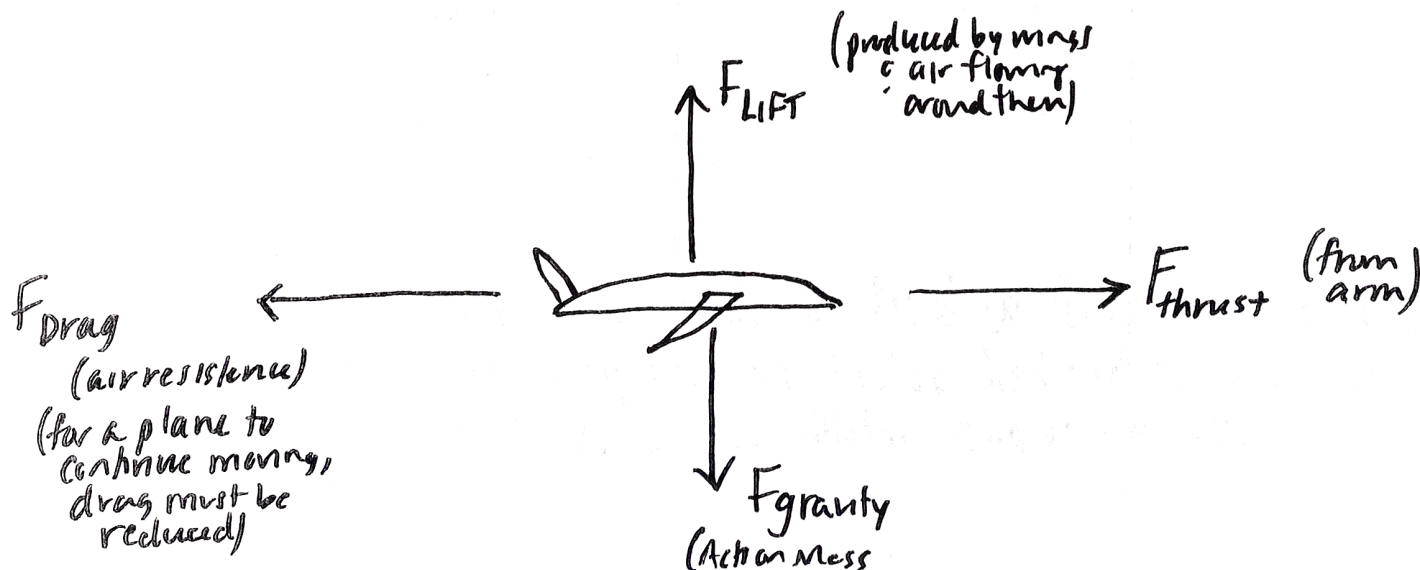
NSL:  $F=ma$ ; For a constant force, a smaller mass will accelerate more than a larger mass; a greater force will make the same mass accelerate more.  
ex: stronger push from hand = plane goes further

NIL: Every action has equal & opposite reaction  
ex: your hand pushes on a plane & plane pushes back on your hand, sending it forward

## Modifications to plane:

↑ Thrust  
↓ drag (streamline body)  
↑ Lift (angle of launch)  
Add mass

If nose drops, bend up back wings  
Add other folds  
Wing shape



Name:

Date:

Day One: Determine Design  
Paper airplane performance

Airplane Model	Distances flown (Fly each plane 5 times)	Features and Notes
1) Dart	5m, 6m, 10m, 9m, 10m	Streamlined - not much drag. Can handle a lot of thrust (hard throw).
2)		
3)		
4)		
5)		
6)		

★ Must make and test at least 6 different designs.  
★ When you have finished, select the best performing design and sketch complete details on back of this page.

Name \_\_\_\_\_

Att. Number \_\_\_\_\_

Day 2:  
Paper Planes

**Independent Variable:** Mass

**Dependent Variable:** velocity and acceleration

**Purpose:** To construct a paper airplane capable of flight so that velocity, acceleration, force and momentum may be calculated and Newton's laws of motion may be tested.

**Hypothesis:** Predict how the shape of the airplane, force applied, and mass will affect the calculated quantities.

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**Part 1:**

1. Choose an airplane design from those presented in the front of the classroom.
2. Fold chosen paper plane.
3. Make 2 copies of your plane (this means you will have 3 paper airplanes in total)
4. Label each plane with your group name.
5. Determine the mass of your plane.
6. Determine the mass of a paper clip.

Note: You may change your design at home, but you must leave lab today with a plane folded. If you use a different design, you must use a standard piece of paper and you may not add or remove any part of the paper.

Mass of Plane 1		g	$\times 10^{-3} =$	kg
Mass of Plane 2		g	$\times 10^{-3} =$	kg
Mass of Plane 3		g	$\times 10^{-3} =$	kg
Average Mass of Planes		g	$\times 10^{-3} =$	kg
Mass of Piece of Paper		g	$\times 10^{-3} =$	kg

Mass of Paper Clip		g	$\times 10^{-3} =$	kg
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**Part 2:**

Materials: Timer, meter stick, airplanes, data sheet

1. For each group, assign a pilot, recorder and a timer.
2. Report to assigned flight area where recorders will mark out a baseline.
3. Pilots will remain behind their baseline and maintain eye contact with their timers for proper synchronization of liftoff times. Press start for liftoff and stop for landing. Launch should be as uniform as possible to control force and momentum.
4. Timers should move to the right side of the start line and maintain eye contact with pilots to ensure proper start and stop times of flight.
5. Recorders should move to the left side of the start line and record measurements and observations. Recorders are responsible for the notes and observation section of the report. Recorders need to note
6. Each flight landing site should be marked with chalk using the recorders initials and trial number. After marking landing site, immediately move back to the sidelines to clear the tarmac for incoming flights.
7. Launch your airplane and record distance. Switch planes if your plane becomes hard to fly.
8. Repeat step 7 three times.
9. Switch roles, add 1 paper clip to your airplane and repeat steps 7 and 8.
10. Switch roles, add a second paper clip, repeat 7 and 8.
11. Switch roles, add a third paper clip and repeat 7 and 8.
12. To reduce the amount of people on the flight area, distance will be recorded after all trials are completed. All team members are required to record the distance and time data.
13. Clean up area of all paper airplanes and return all equipment.

⊛ Show Calculations

⊛ Make Data Table for:

Distance Flown	Time in Air	MASS of Plane	$(d/t)$ Velocity	$(v_f - v_i)/t$ acceleration

(F=ma)  
Force

Plane  
1 paper clip  
2 paper clip  
3 paper clip