

# Paper Airplane challenge

## MATERIALS NEEDED:

- 8.5 X 11" copy paper for airplane folding
- masking tape
- measuring sticks or measuring tape
- \*optional: books/pictures/articles about airplanes, history of flight, paper airplanes, aerodynamics, aerospace engineering (see resource list for suggestions)

## PRINT OUTS NEEDED (all included):

- **Test Fly Zone Posters and Markers (at least one set)**
- **1 Copy per Team:**
  - Thrust Information Card
  - Drag Information Card
  - Weight Information Card
  - Lift Information Card

## PREPARATIONS:

- Set up at least one "Test Fly Zone" in a large unobstructed area:
    - Display copies of *Test Fly Zone* posters to mark the area.
    - Place masking tape on the floor for students to stand behind when throwing airplanes.
    - Measure and tape provided markers at the 5, 10, 15, and 20 foot marks to provide a throwing line (Takeoff Line) and measuring points.
- Use the blank markers to modify marked measurements to best fit your students' needs.

Takeoff Line						
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- Copy the print outs listed above as directed.
- Provide safe place to store paper airplanes in progress.

## PROCEDURE:

1. Explain the rules of the "Test Fly Zone":
  - Do not cross the flight path (where paper airplanes will be thrown).
  - Test Pilots must stand behind the takeoff line to throw paper airplanes & take turns with other pilots.
  - After paper airplanes land, measure distance from the takeoff line to the *first* touchdown.
2. Explain Team Assignment: Your first team assignment is to explore the four forces of flight. Think about how these forces could improve a paper airplane flight.

- Distribute *Information Cards* and *force report sheets* to assigned engineers.

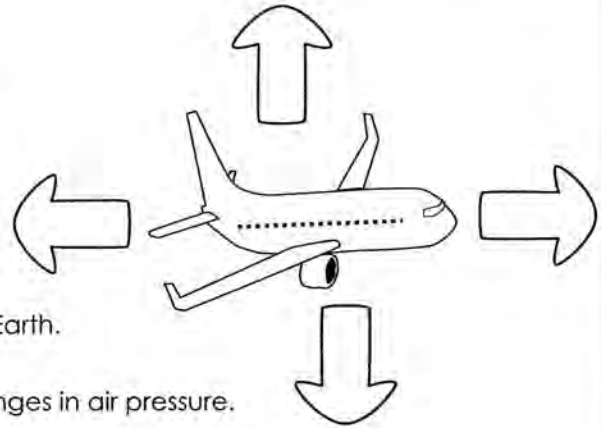
3. Follow the folding method worksheet or fold/create own airplane for the challenge.

**Aerodynamics**

**Aerodynamics** explains how objects fly. The air that moves around an object is described through four forces of flight – weight, lift, thrust, and drag. These forces make up the rules of aerodynamics. Balls, Frisbees, kites, airplanes, rockets, and even birds all react to the rules of aerodynamics when moving through air.



A **force** is a push or pull that changes an object's speed, direction, or shape. An object flies faster, slower, up, or down depending on how much of each force there is. When all four forces are balanced, an object flies.



Weight is the force of gravity pulling down toward Earth.

Lift is the force that moves objects higher from changes in air pressure.

Thrust is the force that moves objects forward, such as an engine or throw.

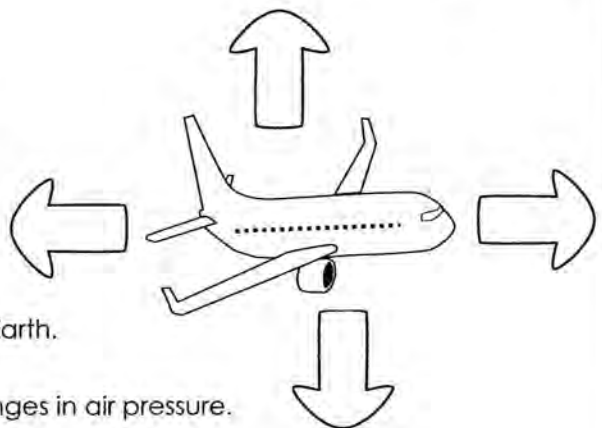
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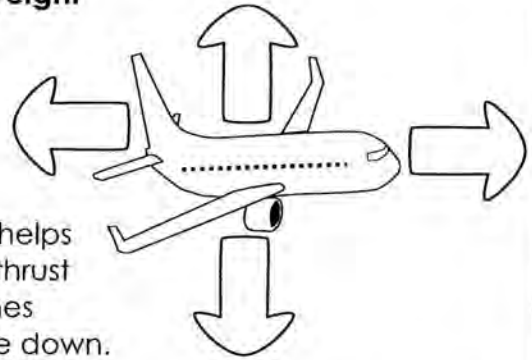
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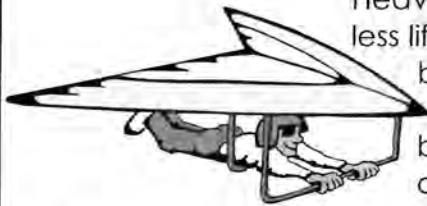
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### Forces of Flight: Weight

**Weight** is the force of gravity pulling down on an object. The amount of downward pull is equal to how heavy the object is. To fly, the force of weight must be less than the force of lift.



When a pilot is finished flying, the force of weight helps the airplane land. The pilot lowers the amount of thrust and less lift is created. The force of weight becomes stronger than the force of lift, bringing the airplane down.



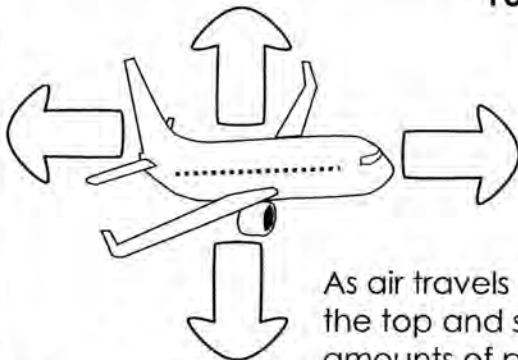
Heavier planes need more lift. When a plane is lighter it needs less lift to fly. A paper airplane that weighs less will fly farther because there is less gravity pulling it down. Weight also changes how an object flies. Weight must be equally balanced for controlled flight. What flying objects or animals can you think of with balanced weight?

**TRY IT!**

How does unbalanced weight affect flight?

Fold a basic paper airplane and fly it. Change the weight by attaching a paperclip to one wing. Move the paper clip for each flight. What do you notice?

### Forces of Flight: Lift



**Lift** is the force that pulls objects up from the ground. The air moving past the shape and angle of a flying object creates lift. The force of lift must be greater than the force of weight, for an object to fly.

As air travels around an airplane wing, it moves faster over the top and slower under the bottom. This creates different amounts of pressure above and below the wing. The higher pressure created under the wing is stronger than the lower pressure over the wing. This high pressure acts as a lifting force allowing the airplane to fly.



Paper airplanes have a different shaped wing but still use the force of lift. Both the size and angle of the wing can create more or less lift to fly the plane farther.

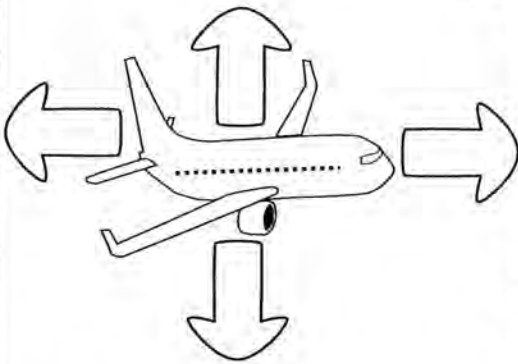
**TRY IT!**

How could the angle of the wing change the amount of lift?

Fold and fly a basic paper airplane. Bend the angle of the wings down and then bend them up. Try folding the wings at different angles. What do you notice?

**INFORMATION CARD – THRUST**

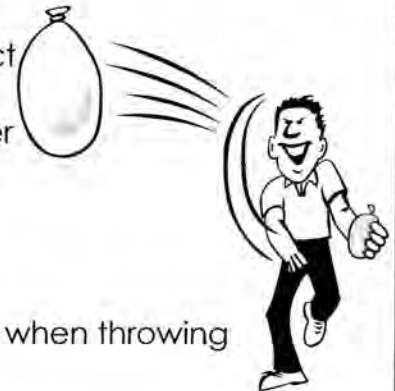
**Forces of Flight: Thrust**



**Thrust** is the force that moves a flying object in a direction, usually forward. To move forward, the force of thrust must be stronger than the force of drag.

Most aircraft use an engine to control a propeller, a jet, or a rocket to create thrust. More or less power from the engine will move the aircraft forward faster or slower.

Flying objects without power, such as paper airplanes or water balloons, are supplied with thrust by how the object is thrown. The harder or lighter the throw, the faster or slower the force of thrust will move the object. What other objects have you thrown with more or less thrust?



**TRY IT!**

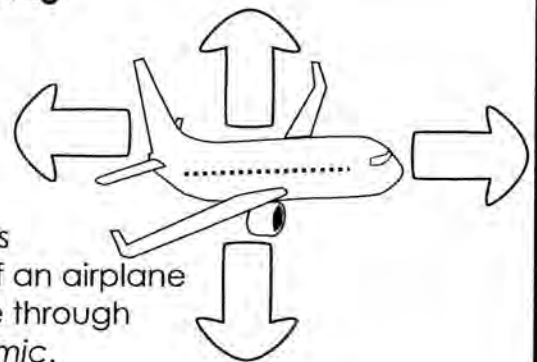
Can you change the force of thrust?

Fold a basic paper airplane. How does the flight change when throwing the airplane with hard or light force?

**INFORMATION CARD – DRAG**

**Forces of Flight: Drag**

**Drag** is the force that slows down forward motion. It pulls against thrust. The shape of an object as it moves through the air can create more or less drag.



Airplanes are designed with a shape that moves through the air more easily. The front, or *nose*, of an airplane is narrow to create less drag. Objects that move through the air with little drag are considered *aerodynamic*.

Drag can also be felt on the ground. If you try running into the wind on a breezy day, you may become more tired. The force of drag slows you down, making you work harder. Drag can also be very helpful. Skydivers are thankful for the drag that slows down their parachutes before landing. Where else have you felt drag?



**TRY IT!**

How do different shapes change the force of drag?

Find a clear area. Throw a crumpled and a flat piece of paper as far as you can. What happened? Why?

# TRY IT YOURSELF

## CHALLENGE

How far can you fly a paper airplane?

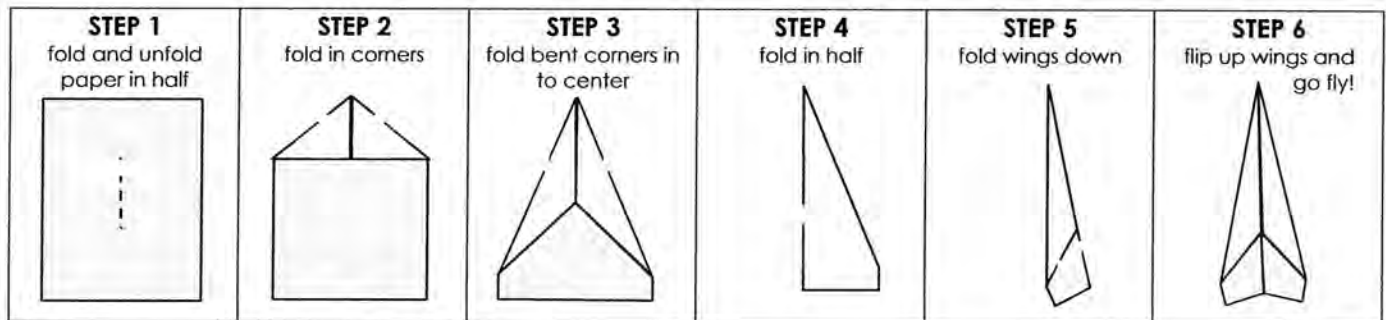
## CRITERIA

You must fold a paper airplane out of a piece of copy paper.  
Write your name on your airplane before flying it.

## CONSTRAINTS

You may only use one piece of copy paper.

**TIPS:** Follow the instructions provided to fold a basic design or use your own folding method.  
Have fun and good luck!



## REFLECT

<p><b>What I Liked About My Airplane</b></p>          <p><b>Next Time, I would...</b></p>	<p><b>What I Didn't Like About My Airplane</b></p>          <p><b>Next time, I would not...</b></p>
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# TEAM BRAINSTORM AND PLAN

**MANAGER:** \_\_\_\_\_  
**TEST PILOT:** \_\_\_\_\_

**AIRCRAFT DESIGNER:** \_\_\_\_\_  
**AIRPLANE MECHANIC:** \_\_\_\_\_

## CHALLENGE:

How far can you fly a paper airplane designed and constructed by your aerospace engineering team?

### 1. Think:

What do we think would make our paper airplane fly farther? _____ _____ _____ _____	What do we think would shorten the flight of our paper airplane? _____ _____ _____ _____
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### 2. Plan: Describe the materials you plan to use and why you chose to use them.

Material:	How/Why it will be used:

### 3. Decide: What do we think would be the perfect paper airplane design?

Drawing of Design	I think this design will work well because
	_____
	_____
	_____
	_____

### 4. Write down any more ideas you have to complete the challenge.

\_\_\_\_\_

\_\_\_\_\_



