ICE RESISTANT AIRPLANE CHALLENGE

TEAM BUILDING ENGINEERING LESSON

Adaptable for grades 3-12

STEMPILOT®

Engaging Students in STEM with Flight Simulation

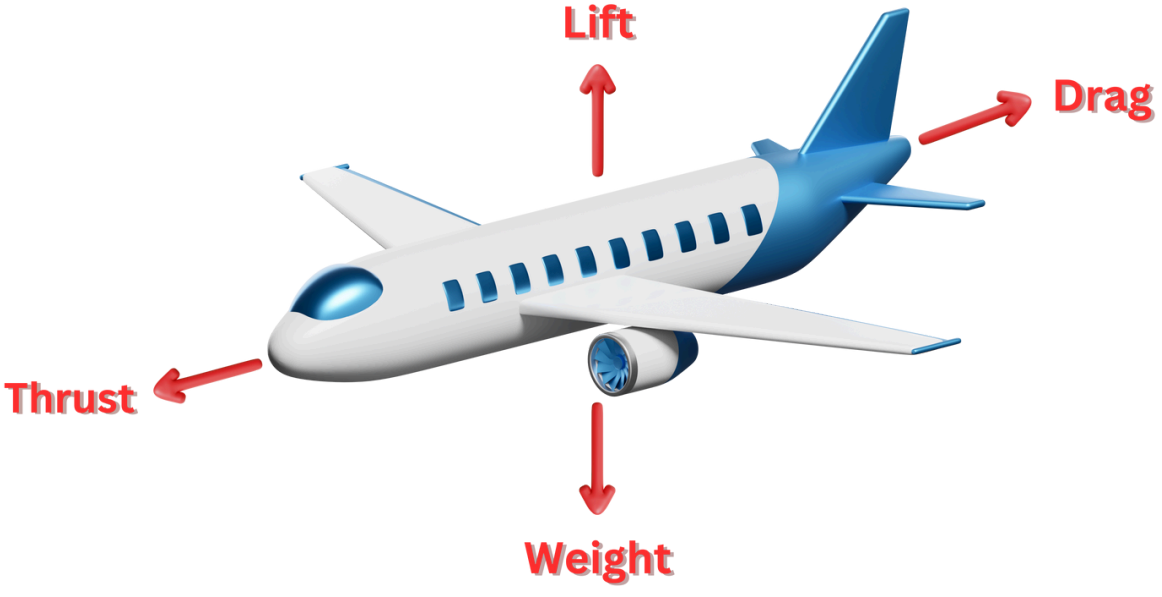
Ice Resistant Airplane Challenge

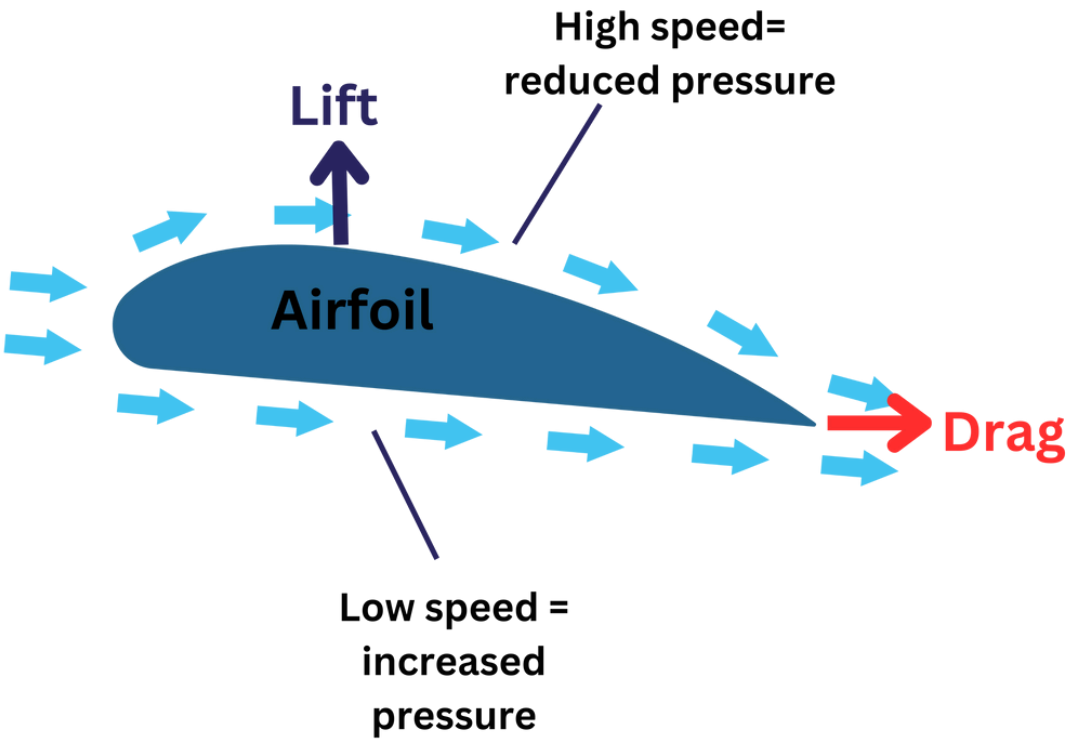
Introduction

Did you know that a layer of ice as thin as a piece of paper can make an airplane too unsafe to fly? Crazy, right? During the winter, airports use special trucks and chemicals to clear the ice, but this costs airlines time, money, and fuel. What if we could design a plane that handles ice all by itself? Today, we're going to explore the science of aircraft deicing and challenge your students to create a blueprint for a futuristic airplane that fights back against winter weather. It's time to think like engineers and make flying safer, faster, and cooler—literally!

Understanding Lift and Drag

Before we jump into designing an aircraft that de-ices itself, let's look at how an airplane flies using lift and drag. Lift is defined as the upward force generated by a object moving through air that allows it to stay in the sky. To create lift, your airplane must have an airfoil where air flows over the curved top of the wing. The faster the air flows, the less air pressure is produced on top of the wing compared to the pressure on the bottom of the wing. The difference in pressure creates a force on the wing that cause the plane to be lifted into the air.





Accompanying lift is drag. Drag is the force that tries to slow an object down, making it harder to move. Drag generally occurs whenever an object is in motion. While the object is traveling through the sky, it will encounter a resistive force, called drag.

How Does Ice and Snow Affect Lift

When ice forms on an aircraft's wings, fuselage, or control surfaces, it disrupts the smooth airflow that's essential for lift. The shape of a wing, specifically designed to create pressure differences for lift, becomes distorted by the rough and uneven ice. This distortion reduces the wing's ability to generate lift, making it harder for the airplane to stay aloft, especially during critical phases like takeoff and landing.

But that's not all—ice dramatically increases drag too. Ice build-up acts like sanpaperpaper on a plane's surface, slowing it down. Even a thin layer of ice can increase drag by as much as 40% and reduce lift by 30%. This means the engines have to work harder just to maintain the same speed, leading to reduced efficiency and increased fuel consumption.

This double whammy—reduced lift and increased drag—makes flying with ice a risky proposition. Pilots and engineers take this seriously, using anti-icing systems, heated surfaces, and deicing fluids to prevent or remove ice buildup. In flight, if ice begins to form, quick action is essential to ensure safety and restore the aircraft's performance.

Dealing With Ice

In order to fight back against icy weather, ground crews work tirelessly to de-ice airplanes. They do this by using the following methods:

Anti-ice - Some planes have built-in systems that prevent ice from forming on the plane. For example, some planes will have windshields that are heated to melt or prevent ice from forming.

Deicing fluid - The most commonly used method is deicing fluid. Ground control would spray the airplane with a heated chemical mixture of propylene glycol and water that thaws the ice within 15 to 90 minutes.

Mechanical removal - In some cases, snow and ice can be easily removed using brooms and scrapers.

Hot air - Some airlines will have systems that use heated air to blow off light and loose snow and ice.

Activity

Now that we have a basic background in how ice affects flight, let's dive into our activty. In this activity, students become aerospace engineers. They will work in teams of 3-4 to create a one of a kind ice resistant airplane. They will then present their design to STEMPilot Airlines Exectuative. They must include the problem their design was created to fix (how to safely and effienctly deice an airplane with a budget), what the plane will look like, the list of materials (for older students to include) and how the airplane will thraw or deice the ice from the planes faster and safer than previous methods.

Materials

- Poster Paper (or digitial design tools: TinkerCad, SketchUp, AutoCad or Canva)
- Rulers
- Pencils/ markers, and erasers
- Chromebooks/ computers (For research)
- STEMPilot Engineering Design Process Diagram Handout
- STEMPilot's Blueprint Key Features Checklist
- TV, SmartBoard or project to display presenations and videos

Duration

Estimated time:
1-3 classes (45-60 minutes each class)

LESSON PLAN

D*ay 1: Research and Idea Sharing*

Preparation:

Make sure to have all your materials ready, like handouts, worksheets, or access to computers, before starting the activity.

- ***Kick-Off (The Hook):***

Show a short video or pictures of planes being deiced before takeoff. Then, ask your students:

- "How would you design a plane that could deice itself during flight?"

Encourage students to share their ideas for a few minutes. Afterward, show short, fun videos like:

- “Why your plane needs to de-ice”
- “How do planes deal with ice while flying?”
- “Southwest Airlines: How we de-ice a plane”

Discussion Time:

- Why is ice a problem for airplanes?
- How do planes get rid of ice right now?
- What cool new inventions could make this even better?

Group Activity:

Split students into small groups (3-4 students per group). Have them research questions like:

- How does ice form on planes?
- How do planes prevent or remove ice during flight?
- What new materials or technology could make this process faster and safer?
- Younger students can brainstorm and sketch simple ideas, while older students can use tools like Chromebooks or drawing apps to create more detailed designs.

Day 2: Designing the Blueprint

Review:

- Talk about the cool ideas from Day 1 and explain what a blueprint is: a drawing that shows how something will be built.

Activity:

Each group will draw or create a detailed design of their plane, showing how it will prevent ice.

- For younger students (Grades 3-5): Use simple drawings with clear labels.
- For middle students (Grades 6-8): Add more details, like what materials they'll use.
- For older students (Grades 9-12): Include scale, measurements, and advanced technology.

Sharing Feedback:

Groups can look at each other's designs and give positive feedback:

- Is the idea easy to understand?
- Does it solve the problem?
- Day 3: Presentation Day

Final Touches:

- Give students time to make last-minute changes to their designs and practice presenting.

Present to the Class:

- Each group shares their idea with the class (or a pretend panel of experts). They should explain:
- Why ice is dangerous for planes.
- How their design works.
- Show their blueprints and ideas clearly.

Reflect Together:

- After all presentations, ask the class: Which ideas were the most creative? What
- challenges might engineers face when building these designs in real life? How
- did teamwork help with solving this problem?
-

Extended Activities

Some extended activities for this lesson are:

- *Grades 3-6:*
  - Ice and flight experiment
    - Use paper airplanes and spray them lightly with water. Place one in the freezer (simulating icing conditions) and leave the other dry. Compare how each plane flies.
  - Weather and Icing Poster
    - Create colorful posters showing weather conditions that cause ice to form on aircraft, such as fog, rain, or snow.
- *Grades 6-8:*
  - Wing Lift Simulation
    - Use a hairdryer to blow air over foil wings. Add small droplets of water to the wing and freeze it. Test the airflow again.
  - Build a De-Icing Model:
    - Challenge students to build a simple model of a de-icing system. For example, simulate “heat” using hand warmers or create a “fluid spray”
- *Grades9-12:*
  - Build an Airfoil and Simulate Icing:
    - Construct airfoil models and coat one with glue or frozen water droplets to mimic icing. Use a fan and airflow sensors to measure lift and drag changes.
  - Drone Icing Simulation:
    - If possible, use small drones to simulate icing conditions. Add lightweight materials to mimic ice buildup and observe performance changes.

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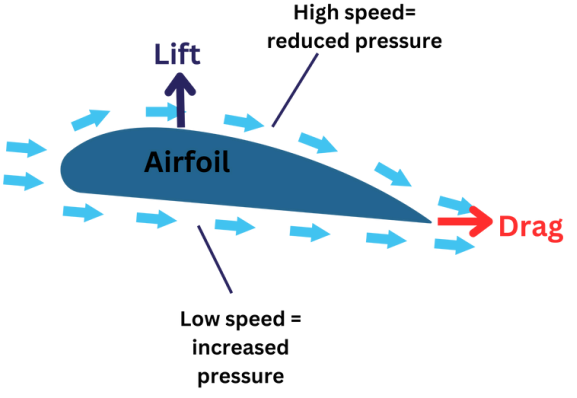
Airfoil Shape and Ice Buildup – The Science of Flight

Main Idea: How wings (airfoils) create lift and why ice makes flying dangerous.

How Does a Wing Work?

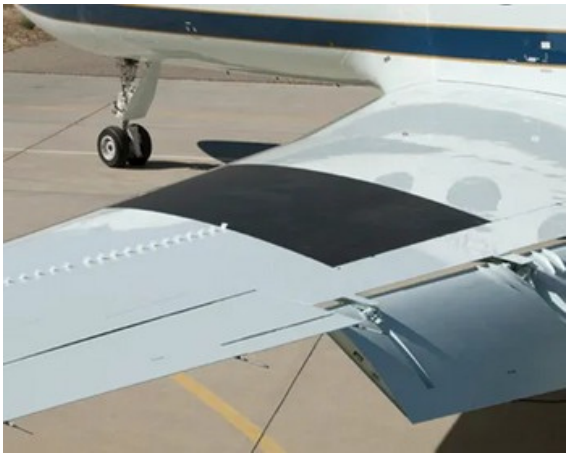
- *Airfoil Shape:*
  - The wing has a curved top and a flat bottom.
  - Fast air flows over the curved top, and slower air flows under the flat bottom.
  - This creates low pressure on top, pushing the wing upward.



What Happens When Ice Builds Up?

- Ice disrupts the airflow because it changes the wing's smooth shape.
  - ***Reduced Lift:*** Less upward force.
  - ***Increased Drag:*** The plane slows down.
  - ***Stalls:*** The plane can lose lift and control.

Smooth Wing



Icy Wing

Real-World Example:

- In 2009, ice buildup on wings contributed to a tragic airplane accident. That's why pilots carefully check for ice and use deicing systems!

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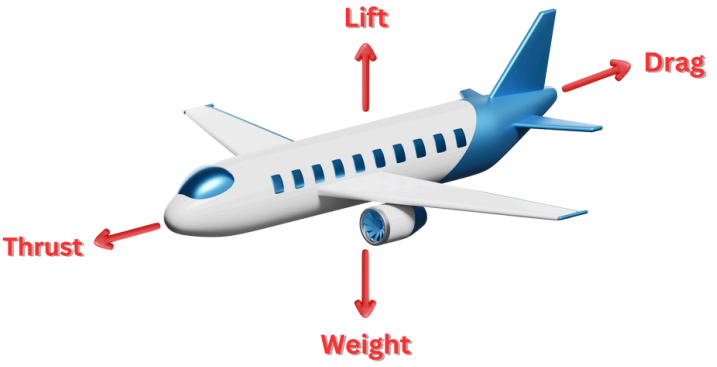
The Four Forces of Flight

Main Idea: Planes fly because of four forces working together.

The Four Forces:

1. **Lift:** Pushes the plane UP.
2. **Thrust:** Moves the plane FORWARD.
3. **Weight:** Pulls the plane DOWN (gravity).
4. **Drag:** Slows the plane DOWN (air resistance).

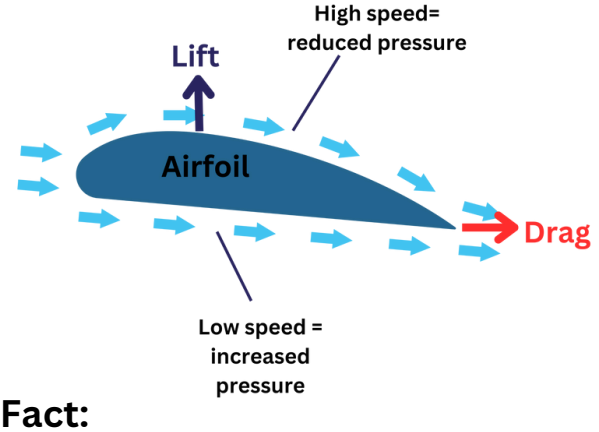


What is Drag?

- Drag is like the air pushing back against a plane. It's harder to run fast through water than air – that's drag slowing you down!

How Does Ice Affect Flight?

- Ice makes the wings "bumpy," increasing drag and reducing lift.
- This makes it harder for the plane to stay stable and fly safely.



Fun Fact:

- Icy wings can make planes act like they forgot how to fly! That's why deicing planes is so important before takeoff.

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What Makes a Plane Fly? – Lift, Drag and Airfoil

Main Idea: Wings, lift, and drag make planes fly!

The Secret Force: LIFT!

1. Lift pushes a plane up into the sky like a giant invisible hand.

2. Airfoil Shape:

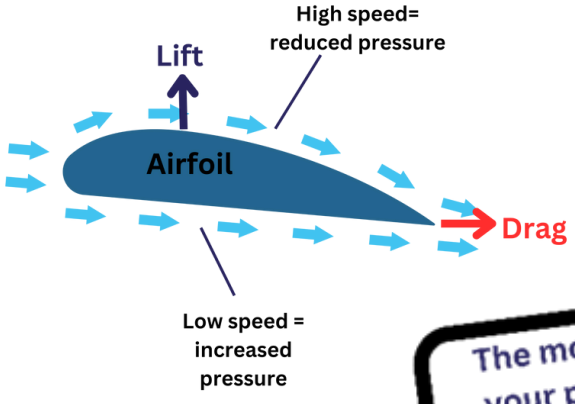
- The curved wing makes air move faster on top and slower underneath.
- Faster air = lower pressure → The wing lifts!

What Slows the Plane Down?

- **Drag:** The air pushes against the plane as it flies forward.

Airfoil Shape:

- An airplane wing is shaped like a teardrop. Air moves faster over the curved top of the wing and slower under the flat bottom. This creates lift!



Key Words to Remember:

- **Lift:** Upward force
- **Drag:** The force that slows down movement
- **Airfoil:** The shape of a wing