How Planes Fly

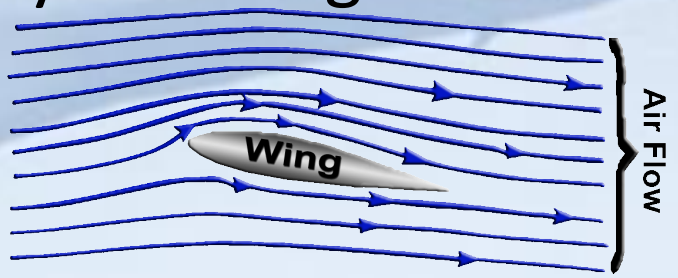
Flight is Complicated

- There is no simple explanation for how planes fly.
- There are models to help us understand how flight is possible.
- The most common models used to explain how planes fly are:
  - Bernoulli's Principle, and
  - Newton's Third Law

Does Bernoulli's Principle Fly?

- Many textbooks claim that Bernoulli's principle explains how airplanes fly. This is the simplest explanation, but not entirely true.

- Air moving quickly over a plane's wing **does** help to lift the plane into the air by reducing the air pressure over the wing, . . .
- But air is also moving quickly under the wing, just not as quickly.
- The pressure is lower over the wing, but not enough to lift a plane into the air.

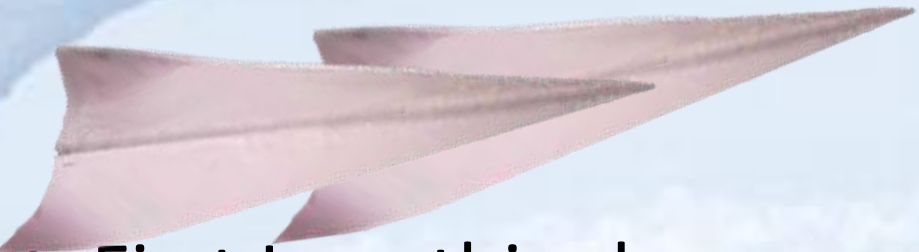


Air moves more quickly over the wing than under it reducing the pressure over the wing. Bernoulli's Principle doesn't explain why the air over the wing moves quicker or how much quicker it moves.

A Paper Airplane

- A simple paper airplane glides straight ahead.

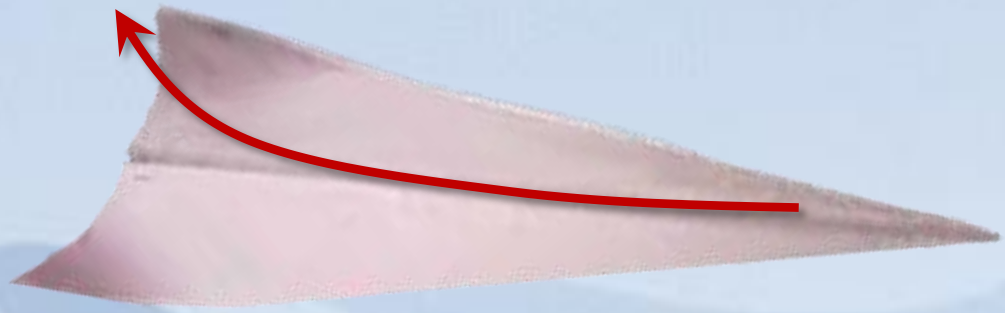
- If you curl the wings up in back, the tail drops and the nose goes up.



- According to Newton´s First Law, this change in direction must be caused by a force.

Turning the Fluid

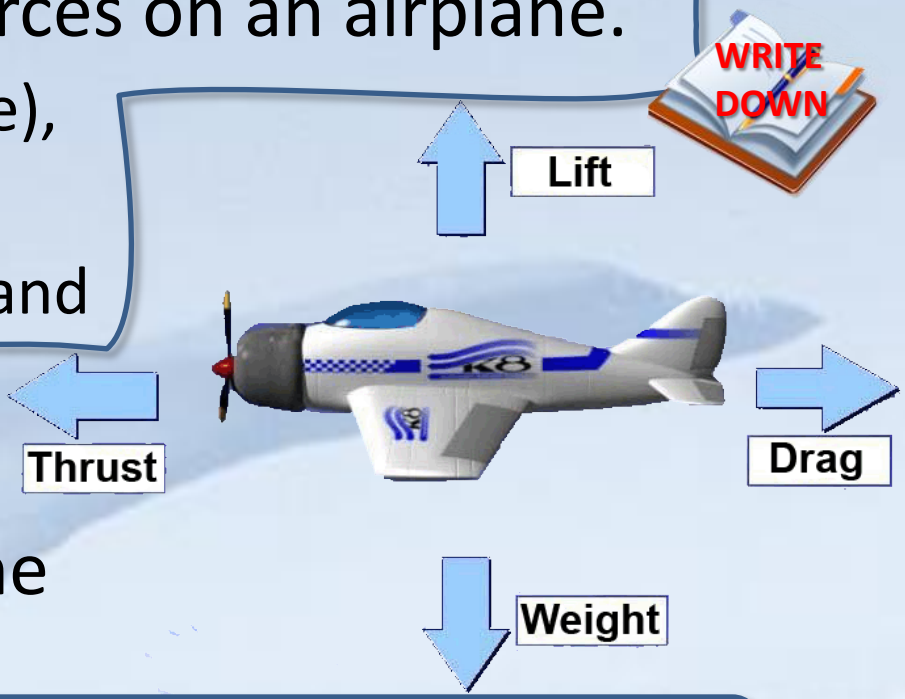
- The curve in the tail of the paper airplane deflects the air upward.



- If the tail of the paper airplane pushes the air up, according to Newton's Third Law, the air will push the tail of the paper airplane down.
  - The action force is exerted when the tail of the paper plane pushes the air up
  - The reaction force is exerted when the air pushes the tail of the plane down.

The Forces on an Airplane

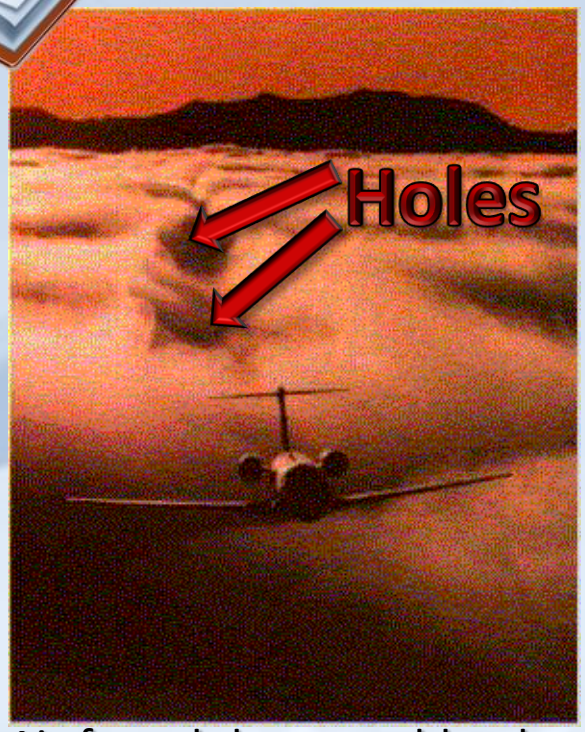
- There are four main forces on an airplane.
  - Thrust (from the engine),
  - Drag (from the air),
  - Weight (from gravity), and
  - Lift



- If the thrust is greater than the drag, the plane moves forward.
- If the lift is greater than the weight, the plane moves upward.

Lift

- The wings of an airplane have flaps that are tilted downward in such a way that they turn the flow of the air downward.
- In reaction, the air pushes up on the wings (Newton's Third Law).
- This lifts the plane into the air.



Air forced downward by the wings of a passing airplane punches holes in the clouds below.