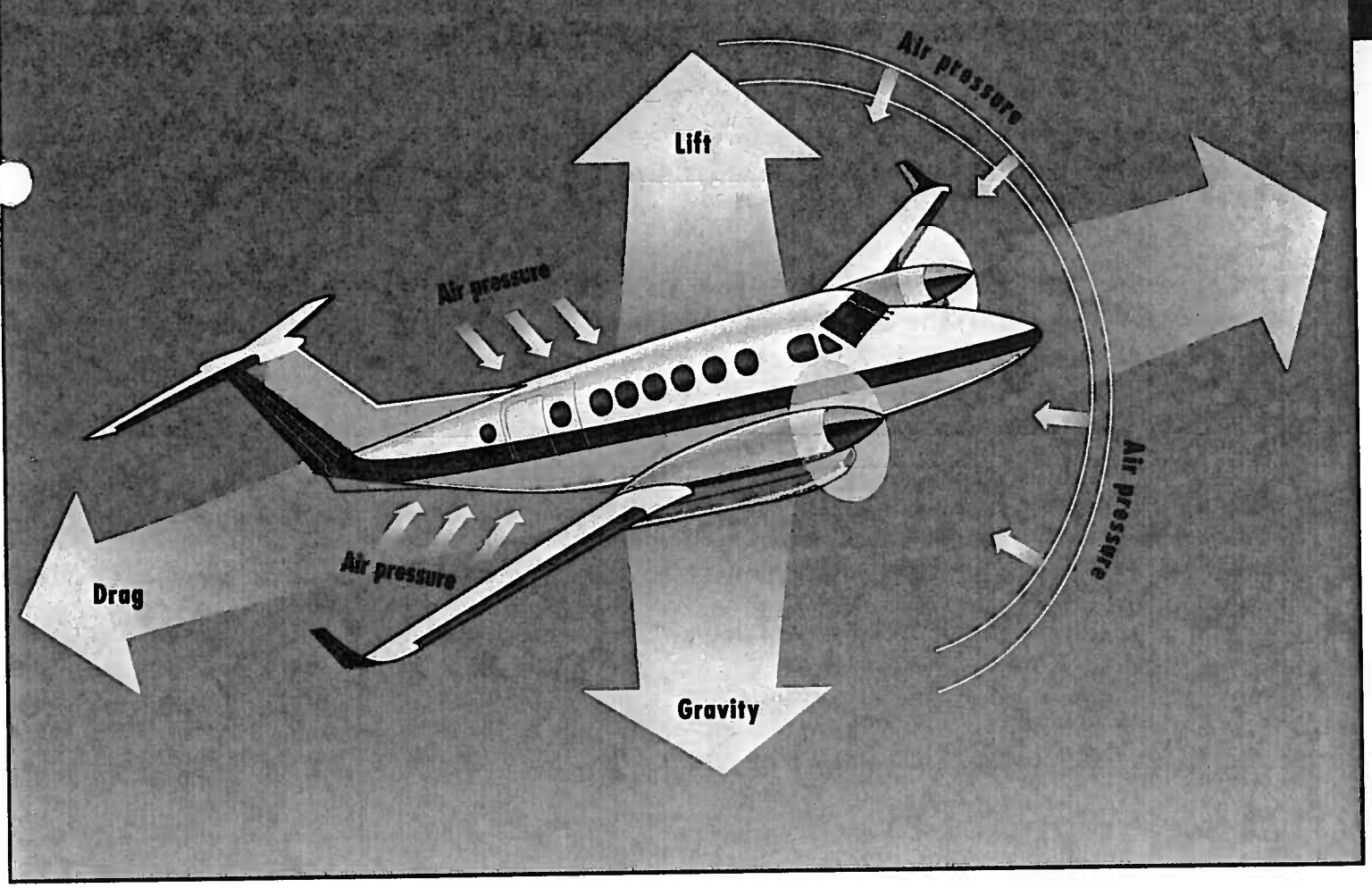


▲ This diagram shows how the forces of gravity, lift, and drag work on a plane. But is this airplane going anywhere? What has to happen for it to fly?

Exploration Connection: It's a drag

Drag is the **aerodynamic** force that acts against an object moving through a fluid. It's what pushes against anything moving through air or water. Do you feel air pushing against you when you walk? Why? What happens when you swim? Why do some things move more easily through air and water than others?

Like gravity, drag is a force that all flying objects have to overcome in order to fly. But drag can be useful, too. What products or devices do you know of that are designed to slow an object's fall? What are some other uses you can think of for drag? Can you think of any way drag might be useful for an aircraft, or a bird?

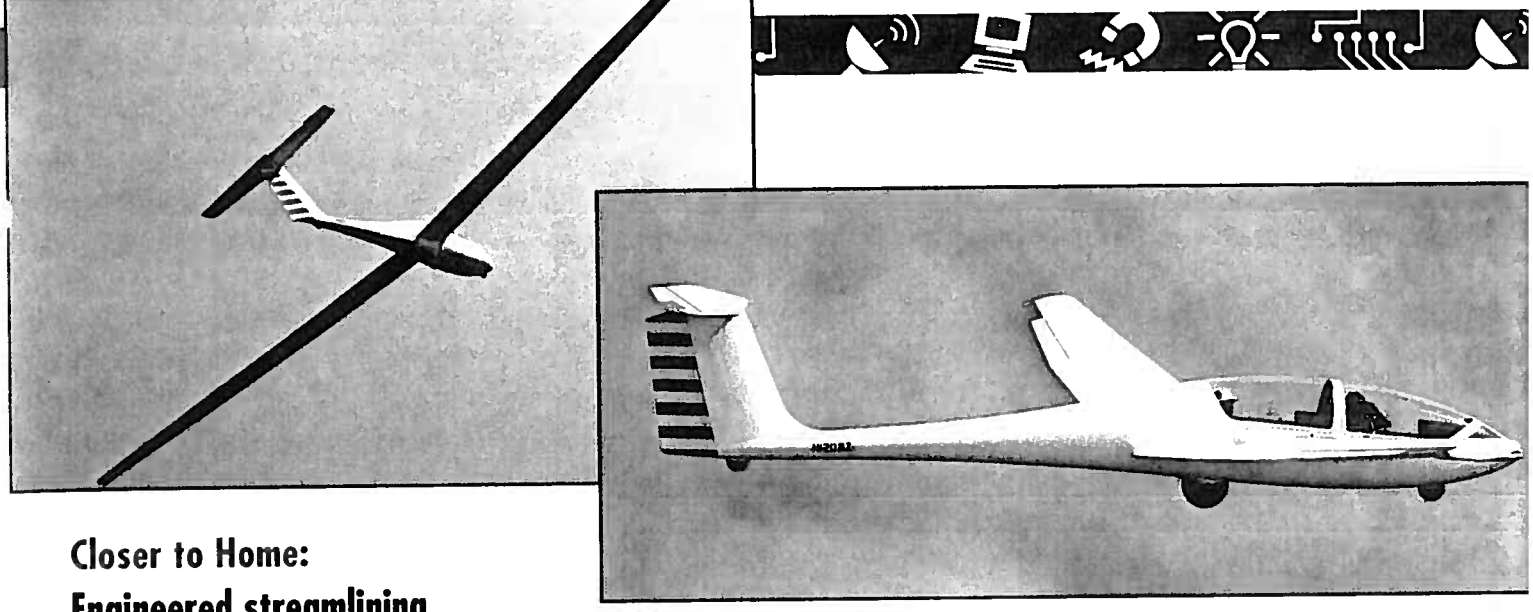
Here are some facts you should know about drag:

a) Drag depends on shape—a shape with low drag is usually long, thin, and smooth, rounded at the front and tapering at the back.

b) Drag depends on speed—drag tends to increase as speed increases.

c) Drag depends on direction—drag acts in the opposite direction to the object's movement.

Some race cars have an upside-down airfoil mounted at the rear. What does it do?



Closer to Home:
Engineered streamlining

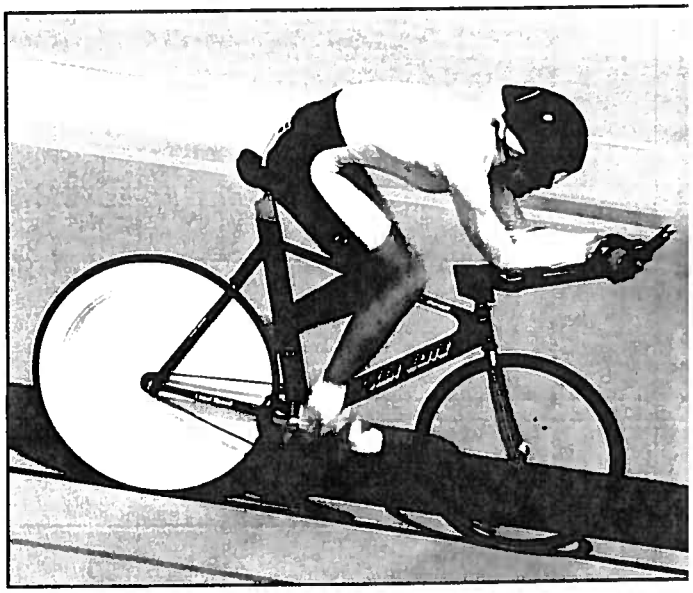
If you tried to blow out a candle while you were holding a file card in front of the flame, you would fail. Why? If you were holding a pop can instead, you might succeed. Why? A file card and a pop can are about the same size, so what would make the airflow around them different?

The shape of an object affects the amount of drag it produces, as you discovered. A streamlined shape produces little drag. Your paper airplane was streamlined. Compared with a file card, a pop can is streamlined. Why?

Streamlining is important not only for airplanes, but also for other vehicles. Automobiles, trains, transport trucks, all experience drag. Engineers design these machines so they will be as streamlined as possible, to reduce the engine power necessary for running them. The designers consider every outside feature of the vehicle and design it so the body is sleek and trim, allowing it to slip through the air easily and smoothly.

Scientists and engineers study flying objects and the effect of the four forces on flight by watching what happens to scale models as air rushes past them in a wind tunnel. It makes no difference if it is the air or the object that is moving, those aerodynamic forces are the same So a wind tunnel provides a perfect tool for studying and testing flight under controlled conditions.

What are some things about flight that you would like to be able to study and test in a wind tunnel? How would a wind tunnel help you explore those things? Computer simulations are another tool aircraft designers use. What features of a computer would make it especially useful for testing and design purposes?



How have both the cyclist and the bicycle been streamlined?

Flying Though a Fluid:
Heavier-Than-Air Aircraft
Pages 327-332

Define lift: _____

Define gravity: _____

Define drag: _____

WHICH HAS MORE DRAG???

Using sheets of paper make the following shapes and determine which one has the greatest drag by timing how long it takes for them to hit the ground.

Object	Time (seconds)
Flat	
Sphere	
Cone	
Cube	