Bernoulli’s Principle

To understand how and why Bernoulli's Principle works, we can consider the following experiment.

Take a room full of children, and ask each child to start running at top speed. Children will start bouncing off each other, and the walls, with impressive collisions (ouch!).

Now take those same children out of the room, and ask them to run down the hall at top speed. Now they are all running together, and all collisions between children are much gentler than before since they are all running in the same direction.

The children in both cases represent the atoms in the fluid, and the force of the collisions represents the pressure between those atoms. In the first case, when the speed of the group as a whole was zero, the jostling (or pressure) was high. In the second case, when the speed of the group as a whole was large, the jostling (or pressure) was low.

The **jostling demo** shows atoms jostling in a stationary fluid. After the fluid starts moving each atom continues to move at the same speed, but most of that speed is used to simply keep up with the fluid so the jostling is reduced. Likewise, this demo shows children jostling in a stationary group. After the group starts running, each child continues to move at the same speed, but most of that speed is used to simply keep up with the group so the jostling is reduced.

Ram Pressure and Static Pressure

The demo above refers to the *pressure*. More specifically, this is referring to *static pressure*, which is the pressure felt by an object or person suspended in the fluid and moving with it. This pressure is static because the suspended object or person is not moving relative to the fluid. In this section only we will discuss another other type of pressure: *ram pressure*.

Static pressure should not be confused with ram pressure, which is the pressure felt by an object because it is moving relative to the fluid. Basically, the fluid is ramming into the moving object, or vice versa.

The ram pressure **increases** when the speed **increases**. This explains the stronger force felt by your hand when it is held a fast moving current. In the faster current, your hand is deflecting more flowing fluid from its original path.

As you wade across a rushing stream, the force against your legs is from the ram pressure, and it is directed downstream.

The static pressure **decreases** when the speed **increases**, as explained in the section above. This explains why the water stream coming out of a firefighter's hose gets narrower a short distance past the nozzle - the stronger atmospheric pressure overwhelms the weaker static pressure in the quickly flowing water and compresses the water stream.

At the bottom of a swimming pool, the force on your body is from the static pressure of the water, and it is directed inwards.

During the moving part of the jostling demo above, static pressure would correspond to the jostling felt by a teacher running along in the center of the children. That pressure would be slight. Ram pressure would correspond to the body blows experienced by an unsuspecting teacher standing in the path of the oncoming crowd (big ouch!).

Demonstrating Bernoulli’s Principle

1. Place a ping pong ball under an inverted clear funnel. Blow into the small tube end of the funnel. The ping pong ball will rise to the top (narrow end) of the funnel.

2. Cut a small hole in the center of a paper plate. Attach a drinking straw to the top of the plate at the hole. Stick a push pin through the bottom center of another paper plate. Place the paper plates on top of each other so that the point of the push pin is sticking into the straw and the straw is sticking up. Hold the plates up like this and start blowing threw the straw. You should be able to let go of the bottom plate while blowing into the straw without the plate falling. When you stop blowing through the straw, the plate will fall.

3. Hold a beach ball in the air stream of an air blower that is aimed upward. The ball should remain in the air stream even when the air stream is significantly tilted. The surface of the ball is not smooth and the ball will rotate in the direction of the pressure gradient.