Newton's Laws

Newton's laws of motion are three physical laws which provide relationships between the forces acting on a body and the motion of the body, first compiled by Sir Isaac Newton. Briefly stated, the three laws are:

1. Law of Inertia: An object in motion will remain in motion unless acted upon by a net force.
2. Law of acceleration: Force equals mass multiplied by acceleration.
3. Law of reciprocal actions: To every action there is an equal and opposite reaction.

Demonstrations of Newton's First Law – The Law of Inertia

1. Boiled and Raw Eggs: Spin the eggs, one at a time, on the side on a smooth hard surface, stop them fast and let them go immediately. The boiled egg will spin easily to begin with but will not spin any more after stopped suddenly and released. However, the raw egg will spin again after quick stopping and releasing it because the liquid inside the raw egg is still in motion due to inertia. Please wash your hands when handing raw eggs. This technique can be used to find out if the egg is raw or boiled.

2. Inertia of Air Molecules: Spread a large sheet of paper (2 legal sheets of paper taped together or a newspaper sheet) on the table aligning its edge with the edge of the table. Insert and center a 10-12 inch long, 1 inch thick stake under the paper with less than half protruding out from the paper/table edge. Hit the stake fast with your hand (like karate chop) closest to the table without hitting the tabletop. The stake will break if done correctly. Do not touch the paper when the stake is being hit. The paper surface is carrying an air pressure of 15 pounds per square inch and when the stake is hit, it tries to accelerate the air above the paper surface which offers resistance enough to cause the stake to break.
Caution: The students should be moved a little far from the activity as the shattering wooden pieces can hit somebody and might cause injury.
Note from Melinda: I tried this with a chop stick, which seemed to be too strong. The chop stick did not break, but the paper did not fly up as some might think it would and if the chop stick was placed on the fold of the newspaper, the paper tore.

3. Stack of Coins: Stack coins one above the other on a flat surface. Hit one of the bottom coins with the edge of the spatula. That quarter will come out and the others in the stack will slide down. The coins can be removed one at a time. Since coins are just sitting one above the other and when one of them is hit sideways, the ones in the immediate vicinity resist that motion and the stack slide down under effect of gravity. Another fun inertia trick is to stack coins on one elbow and catch them with the same hand (right elbow & right hand or left elbow & left hand).

Gravity and Newton's Second Law – The Law of Acceleration

Gravity is the invisible force that causes objects to move toward each other. The strength of the gravitational force depends on the size of the objects and the distance between them. The larger an object is, the more gravitational pull it exerts on other objects. The farther objects are from each other, the less their gravitational pulls affect each other.

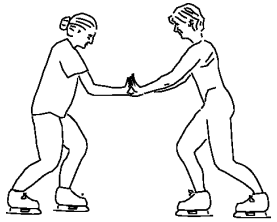
Weight is the gravitational force that affects a small object located on a big object. Mass is the amount of substance an object has. A person has the same mass on Earth as on the moon, but weighs more on Earth than on the moon because the Earth is bigger than the moon.

A person suspended above the Earth (or jumping out of an airplane – hopefully with a parachute) will accelerate towards the surface of the Earth because of the force of gravity. The combination of a parachute and Earth's atmosphere provides an opposing force (air resistance) that slows the person down. At a certain speed, the forces of gravity and air resistance will be balanced, and the speed of the parachutist will stay the same for the rest of the drop. This speed is called terminal velocity.

Ice Skating and Newton's Third Law – The Law of Reciprocal Actions

The basic stroke in ice skating provides a good example of Newton's third law. When you "stroke" (the basic push in ice skating), you apply a backwards force to the ice. The ice applies an equal, forward force on you, so you go forward. Skaters stroke at an angle, so part of the stroke is wasted. You're pushing forward and to the side. The side push is resisted by the edge of your other blade. The forward push is resisted only by the friction between the ice and your blade, so you go forward.

Another example of Newton's third law in ice skating is shown in the picture. When two skaters push away from each other the force exerted on each is equal. If they are the same mass, they will accelerate away from each other at the same rate. If one is larger than the other, Newton's second law tells us that the equal forces will cause the smaller one to accelerate faster.



This is also why sailboats go forward, not sideways. The wind pushes the boats forward and to the side. The sideways push is resisted by the long keel, but the forward push is relatively unresisted. Boats are designed to be aerodynamic (actually, "hydrodynamic) to forward motion and are intentionally not hydrodynamic to sideways motion.