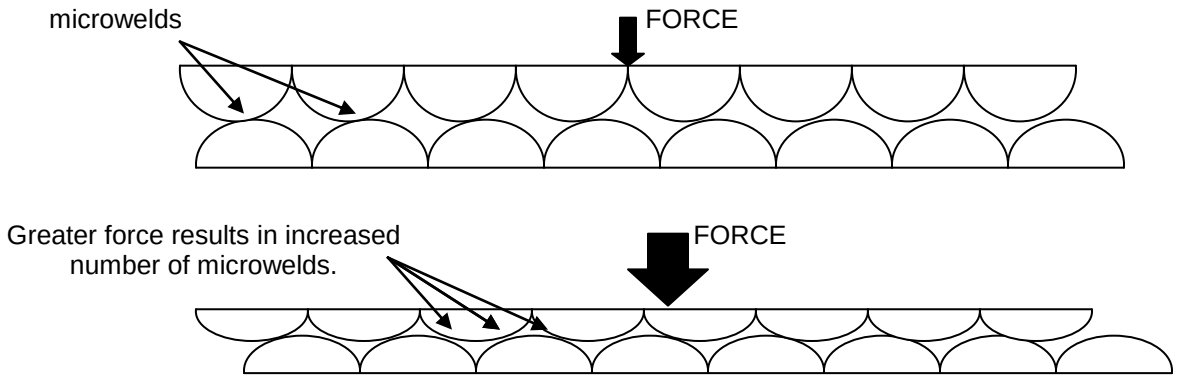
FRICTION

Imagine pushing a skateboard on a level surface. According to Newton's first law, that skateboard will continue to roll in a straight line until an outside force acts upon it. You probably already know that the skateboard will not continue to roll at a constant speed after it leaves your hand. Eventually, it will slow and come to a complete stop. It therefore makes sense to assume that there is some outside force causing the skateboard to slow and eventually stop. You might already know that this force is called **friction**. There are many different types of friction, and the type of motion determines the type of frictional force that interacts with the object. Four that we will discuss are ***static, rolling, sliding and fluid.***

MICROWELDS

Even surfaces that seem extremely smooth and polished have little bumps on their surface. You need a microscope to see them, but it is important to know that they exist. If the surfaces of these two objects are forced together, the surfaces tend to "weld" or stick together. The places where this sticking occurs is called a microweld. Friction is caused by the formation of these microwelds when two different surfaces come in contact with one another. The greater the force applied between the two objects, the greater the resulting frictional force due to an increase in the number of microwelds.



HEAT AND FRICTION

Remember that heat is caused by the collision of particles (atoms & molecules) of matter. Friction causes these collisions to occur and heat is generated. Recall that you can warm your hands by rubbing them together. Sometimes the heat produces is very small and we have difficulty sensing or feeling it. The important thing to remember is that heat is produced where ever friction is present. Other times the heat produces is quite noticeable. The bottom of the space shuttle collides with particles of air as it re-enters earth's atmosphere. These collisions produce trememendous amounts of heat. Special tiles are made to withstand the heat produced during re-entry.

STATIC FRICTION

Have you ever tried to slide a large box across the floor that is too heavy to lift? You might remember that the object required substantial force to get it to move. In addition to having a large inertia (due to it's large mass), a static frictional force is also at work making it difficult to move the box initially. The weight of the box causes microwelds between the bottom surface of the box and the surface of the floor that it is resting on to form. The formation of microwelds between the surfaces of two stationary objects is called **static friction.** The force produced by these microwelds must be overcome in order to move the box from it's resting position.

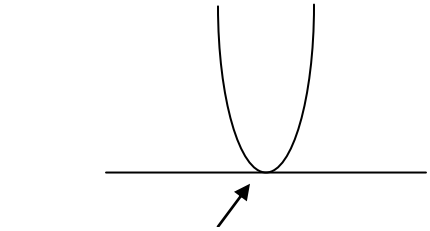
SLIDING FRICTION

Suppose you were able to apply enough of a force to overcome the static friction produced by the microwelds. The box would begin to move sliding across the floor. Microwelds would begin to form and break while the two surfaces slide past one another. This forming and breaking of microwelds is called **sliding friction.**

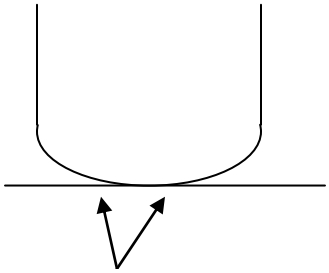
ROLLING FRICTION

If you could zoom in using a microscope to see where the wheel of a bicycle comes in contact with the road, you would find that the rubber on the wheel deforms and takes the shape of the road. This is good in a sense, because you want to maintain control of your bike and the deformation of your tire against the road provides just enough friction to maintain control, but not so much friction that it is too difficult to overcome this force, called **rolling friction**.

Rolling friction increases as does the surface area that deforms, causing more momentary microwelds to form. This is why road bikes tend to have smaller, thinner tires to help them go faster. These tires generally are inflated to a very high pressure to reduce the surface area, hence microwelds and ultimatelty rolling friction. Tires designed for mountain bikes are not designed for speed rather traction and durability. They are usually much wider. This width increases the surface area that deforms, increases the number of microwelds that form and ultimately the rolling friction.

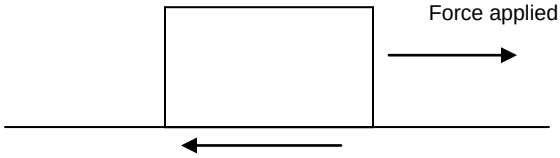


Decreased surface area between tire and road reduces rolling friction

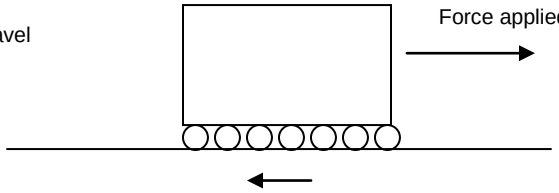


Increased surface area between tire and road increases rolling friction

The Egyptians realized that rolling friction was less than sliding friction when constructing their great pyramids. This is why they used round logs to help move the giant blocks during construction.



Sliding friction is greater due to increased number of microwelds between two surfaces.



Rolling friction is less due to decreased number of microwelds between two surfaces.

FLUID FRICTION

Air and water are considered fluids. Fluid friction in air is usually called “air resistance” or “drag.” The thickness or ***viscosity*** of the fluid determines the amount of friction in a fluid. If you were to pour a cup full each of fluids such as honey and water, you would notice that the honey takes much longer to pour than the water. We say that the honey is more viscous than the water. Trying to swim or drive a boat in an ocean of honey would be difficult because of the increased viscosity and fluid friction.

Air Resistance

Air resistance is the force that opposes the movement of objects through the air. As objects move through air, the molecules of air collide and move along the surface of the moving object. These collisions and movement along the surface produce a force in the opposite direction of travel that slows the object down. The size and shape of the object influences the amount of resistance that the object encounters. Airplanes, rockets, and modern cars are designed to “slice” through the air with minimal air resistance. Their surfaces are smooth and the area exposed to the air as it passes over the surface is reduced as much as possible. Parachutes on the other hand are designed to take advantage of air resistance to slow falling objects enough so as not to injure the cargo or passenger.

TERMINAL VELOCITY

Objects fall to earth due to gravity. The force of gravity is constant and acts on all objects equally. Falling objects begin to pick up speed as they fall. Without air resistance, they would theoretically continue to increase in speed as they distance they fall increases. However, air resistance ensures that all objects that fall reach what is called terminal velocity. **Terminal velocity** is the highest speed a falling object can reach. Terminal velocity is not the same for all objects. Size, shape and mass all determine the terminal velocity of an object.