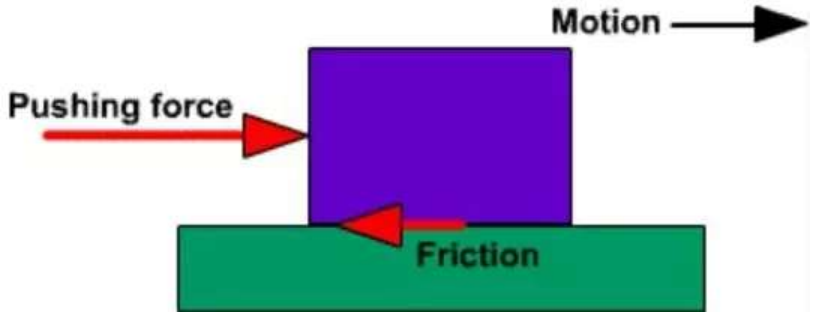
Physics Honors: Friction

FRICTION OPPOSES MOTION

Friction acts in a direction opposite to an object's motion.

If the object is not moving when there is a force attempting to make it move, friction acts in a direction opposite to that force.

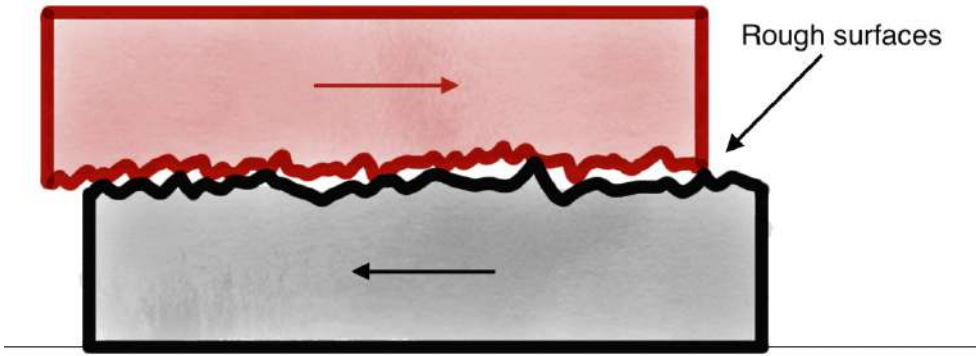


WHAT CAUSES FRICTION?

Friction is caused by the roughness of the two surfaces.

Even though a surface may feel smooth, at the microscopic level it is actually rough.

The two surfaces are in contact in just a few places.



TYPES OF FRICTION

There are two types of friction: friction that prevents motion and friction that occurs when an object is in motion.

Static friction: The force that resists the initiation of sliding motion between two surfaces that are in contact and at rest. Static friction prevents motion.

Kinetic friction: The force that opposes the movement of two surfaces that are in contact and are sliding over each other. Kinetic friction occurs when an object is in motion.

Static and Kinetic Friction

For example, imagine pushing on a couch.

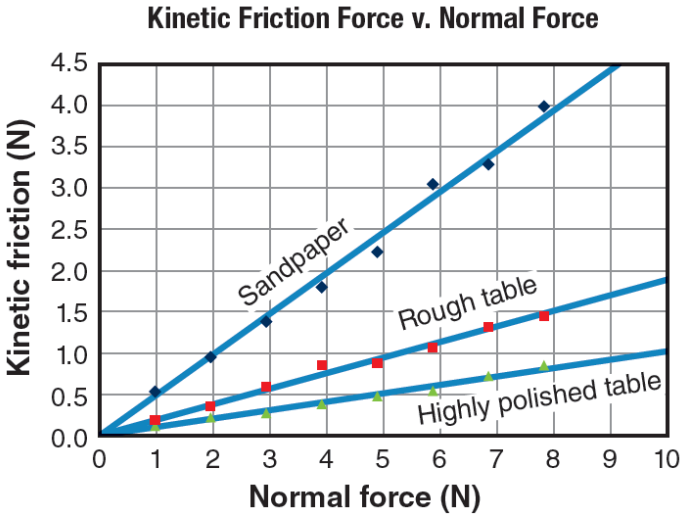
If you are exerting a force on the couch, but the couch does not move, there is static friction. The static friction prevents the couch from moving.

If you push harder and the couch begins to move, you have overcome the static friction. Now that the couch is in motion, there is kinetic friction resisting your push.

Static and Kinetic Friction

Frictional force depends on the materials that the surfaces are made of.

The different lines correspond to dragging a block along different surfaces.



COEFFICIENTS OF FRICTION (μ)

A coefficient of friction is a ratio of the force of friction to the normal force between two surfaces

Coefficients of friction depend on the material of the surfaces

Coefficients of friction do not have units

COEFFICIENTS OF FRICTION

The following table shows the coefficients of friction for various materials. What do you notice?

Table 2 Typical Coefficients of Friction*

Surfaces	Coefficient of static friction (μ_s)	Coefficient of kinetic friction (μ_k)
Cast iron on cast iron	1.1	0.15
Glass on glass	0.94	0.4
Leather on oak	0.61	0.52
Nonstick coating on steel	0.04	0.04
Oak on oak	0.62	0.48
Steel on steel	0.78	0.42
Steel on steel (with castor oil)	0.15	0.08

COEFFICIENTS OF FRICTION

Notice that the coefficient of static friction is always greater. It is more difficult to get an object to move than to keep it in motion.

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CALCULATING THE FORCE OF FRICTION

$$F_f = \mu F_N$$

F_f: Force of friction

F_N: Normal force

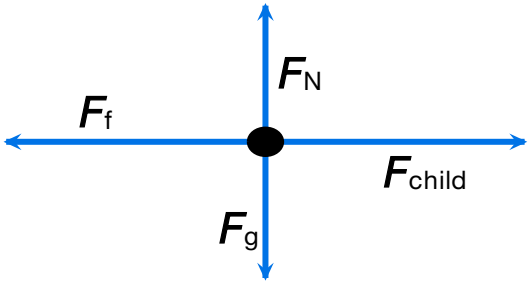
μ: Coefficient of friction

This means the frictional force is affected by the mass of the object and the roughness of the surfaces.

Example

A child drags a heavy, rubber-soled shoe by its laces across a sidewalk at a constant speed of 0.35 m/s. The shoe has a mass of 1.56 kg and the coefficient of kinetic friction is 0.65. What is the force exerted by the child? (Assume the sole is in contact with the sidewalk, not bouncing around and that the child pulls horizontally.)

KNOWN
$v = 0.35$ m/s
$m = 1.56$ kg
$\mu_k = 0.65$
UNKNOWN
$F_{child} = ?$



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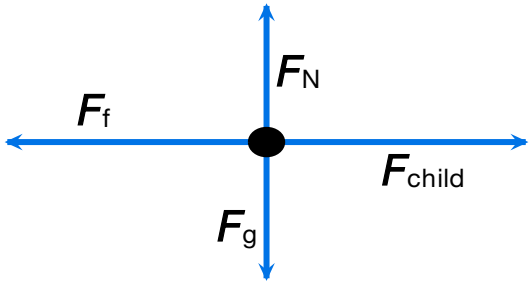
Because there are no other forces in the y-direction, we know:

$F_N = Fg$

From the x-direction we know:

$F_{child} - F_f = ma$

Because the shoe is at a constant speed, a=0.



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Our equations

$F_N = F_g = mg = (1.56\ kg)(9.8\ m/s^2) = 15.29\ N$

$F_{child} - F_f = 0$

$F_{child} = F_f = \mu F_N = (0.65)(15.29) = 9.9\ N$