Name: _____

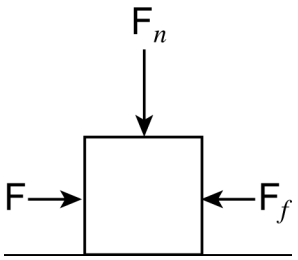
Skill Sheet 6.2 Friction

Friction is a force that resists motion in all real-world mechanics. This skill sheet will provide you with the opportunity to practice solving problems that involve static friction and sliding friction. Static friction is the friction between two surfaces that are not moving. Sliding friction is the friction between two moving surfaces.

1. Calculating friction

In the illustration below, a force (F) is applied to an object. This force is resisted by friction (F_f), also a force.

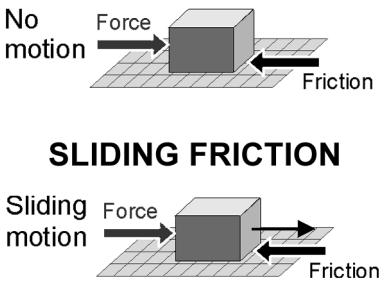
Note that the normal force, (F_n), includes all forces pressing the moving surfaces together.



Here is the equation for finding friction:

Friction

Friction force (N) $F_f = \mu F_n$ Normal force (N); Coefficient of friction



In this equation:

- F_f = force of friction.
- μ = coefficient of friction.
- F_n = normal force (force pressing together).

Example: A cinder block sitting on a sidewalk weighs 90 newtons. The coefficient of friction is 0.4. How much force is required to start the block sliding?

$$F_f = \mu \times F_n$$
$$F_f = 0.4 \times 90 \text{ N}$$
$$F_f = 36 \text{ N}$$

To slide the block, F must be greater than 36 N.

2. Static friction

Solve these problems and state your answers in the following way: "More than _____ newtons of force is needed." Fill in the blank with the correct number of newtons.

1. A huge pile of leaves was wrapped in a tarp in the middle of a lawn. The wrapped leaves weigh 580 newtons. The coefficient of friction for the lawn is 0.55. How much force is required to start sliding the wrapped leaves?

2. Although the collie Lassie could easily pull the 110-newton sled empty, she could not even budge it with 380-newton Timmy aboard. How much force would Lassie have to apply to slide the sled with Timmy aboard? Assume a coefficient of friction of 0.15.

3. The plastic wading pool weighs 50 newtons. But the water in it weighs 4,000 newtons. How much force is required to slide the filled pool if the coefficient of friction is 0.22?

4. The boys pushed and pushed. At an applied force of 804 newtons, they were just able to move the 1,340-newton car. What was the coefficient of friction?

5. At an applied force of 530 newtons, the boulder just began to slide. Assuming a coefficient of friction of 0.65, how much did the boulder weigh?

3. Sliding friction

Sliding friction is usually less than static friction. Each of the problems below is related to those in part 2.

1. Although the pile of leaves in the tarp still weighed 580 newtons, once the family that had raked and wrapped them up got the huge bundle moving, it was easy to keep it moving. The family estimated that they were applying 93 newtons of force. What was the coefficient of sliding friction?

2. Aboard the sled, Timmy kicked off with his feet, and although it wasn't easy, Lassie was able to pull the combined 490-newton weight of sled and Timmy. Assuming that the sliding coefficient of friction was 0.05, how much force was Lassie applying to the sled?

3. The children had been splashing in the pool all day. Their father was surprised that he could drag the plastic wading pool over the wet grass if he gave it a jerk to get it started. Assume the coefficient of sliding friction is now 0.08. How much force must he apply to the 4,050-newton pool (and water) once it is moving?

4. The boys were relieved to find that the 1,340-newton car was easier to push once it got going. Just how hard did they have to push, assuming a coefficient of friction of 0.4?

5. Try to do this one logically in your head. The boulder in problem 5 in Part 2 required 530 newtons of force to just begin to slide at a coefficient of static friction of 0.65. What is the coefficient of sliding friction if the force required to keep it moving is 265 newtons, half of the 530 newtons? Check your work using the boulder's weight you calculated in the earlier problem.