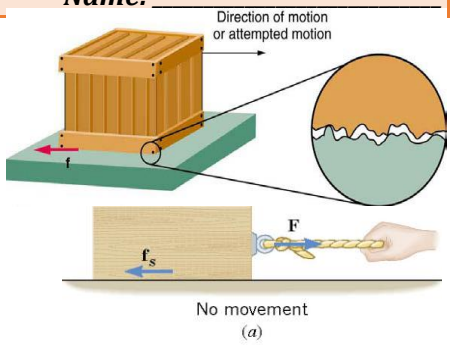
Physics 02-03 Friction **Name:** _____

Normal force – _____ to surface

Friction force – _____ to surface, and _____ motion

Comes from _____

Not well understood



Static Friction

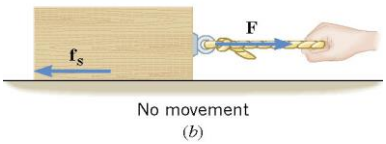
Keeps things from _____.

Cancels out _____ force until the applied force gets too _____.

Depends on force pushing _____ and _____ of surface.

$$f_s \leq \mu_s F_N$$

μ_s is _____ _____ of static friction (0.01 to 1.5)

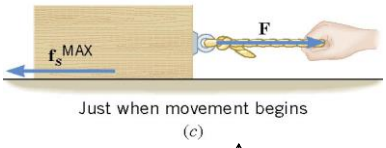


Kinetic Friction

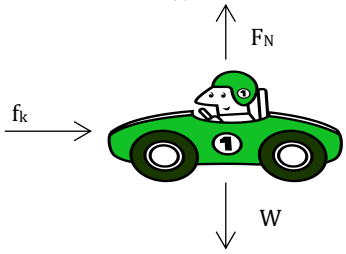
Once motion _____

$$f_k = \mu_k F_N$$

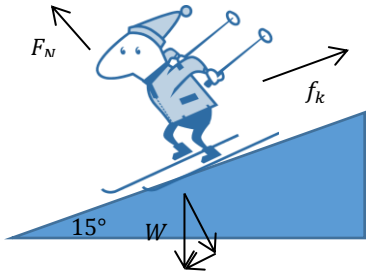
f_k is usually _____ f_s



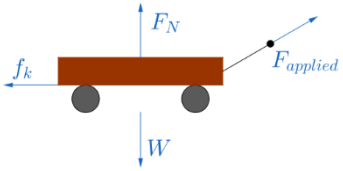
A car skids to a stop after initially going 30.0 m/s. μ_k = 0.800. How far does the car go before stopping?



A 65-kg skier is coasting downhill on a 15° slope. Assuming the coefficient of friction is that of waxed wood on snow (μ_k = 0.1), what is the skier's acceleration?



While hauling firewood to the house, you pull a 100-kg wood-filled wagon across level ground at a constant velocity. You pull the handle with a force of 230 N at 30° above the horizontal. What is the coefficient of friction between the wagon and the ground?



Physics 02-03 Friction ***Name:_____***

Homework

1. A box rests on the floor of an elevator. Because of static friction, a force is required to start the box sliding across the floor when the elevator is (a) stationary, (b) accelerating upward, and (c) accelerating downward. Rank the forces required in these three situations from smallest to largest.
2. Define normal force. What is its relationship to friction?
3. When you learn to drive, you discover that you need to let up slightly on the brake pedal as you come to a stop or the car will stop with a jerk. Explain this in terms of the relationship between static and kinetic friction.
4. A block whose weight is 45.0 N rests on a horizontal table. A horizontal force of 36.0 N is applied to the block. The coefficients of static and kinetic friction are 0.650 and 0.420, respectively. Will the block move under the influence of the force, and, if so, what will be the block's acceleration? (Cutnell 4.37) **3.72 m/s²**
5. A 20.0-kg sled is being pulled across a horizontal surface at a constant velocity. The pulling force has a magnitude of 80.0 N and is directed at an angle of 30.0° above the horizontal. Determine the coefficient of kinetic friction. (Cutnell 4.39) **0.444**
6. A cup of hot chocolate is sitting on the dashboard of a car that is traveling at a constant velocity. The coefficient of static friction between the cup and the dashboard is 0.30. Suddenly, the car accelerates. What is the maximum acceleration that he car can have without the cup sliding backward off the dashboard? (RW) **2.94 m/s²**
7. An 81-kg baseball player slides into second base. The coefficient of kinetic friction between the player and the ground is 0.49. (a) What is the magnitude of the frictional force? (b) If the player comes to rest after 1.6 s, what was his initial velocity? (Review) (RW) **389 N, 7.68 m/s**
8. What is the maximum frictional force (μ =0.016) in the knee joint of a person who supports 66.0 kg of her mass on that knee? (OpenStax 5.3) **10 N**
9. Suppose you have a 120-kg wooden crate resting on a wood floor (μ_s = 0.5, μ_k = 0.3). (a) What maximum force can you exert horizontally on the crate without moving it? (b) If you continue to exert this force once the crate starts to slip, what will its acceleration then be? (OpenStax 5.4) **588 N, 1.96 m/s²**
10. (a) If half of the weight of a small 1.00×10^3 kg utility truck is supported by its two drive wheels, what is the maximum acceleration it can achieve on dry concrete ($\mu_s = 1.0$)? (b) Will a metal cabinet lying on the wooden bed of the truck slip if it accelerates at this rate ($\mu_s = 0.5$)? (OpenStax 5.5) **4.9 m/s², No**
11. Calculate the deceleration of a snow boarder going up a 5.0° slope assuming the coefficient of friction for waxed wood on wet snow ($\mu_k = 0.1$). (OpenStax 5.10) **1.83 m/s²**
12. (a) Calculate the acceleration of a skier heading down a 10.0° slope, assuming the coefficient of friction for waxed wood on wet snow ($\mu_k = 0.1$). (b) Find the angle of the slope down which this skier could coast at a constant velocity. (OpenStax 5.11) **0.737 m/s², 5.71°**
13. A contestant in a winter sporting event pushes a 45.0-kg block of ice across a frozen lake as shown in the picture ($\mu_s = 0.1, \mu_k = 0.03$). (a) Calculate the minimum force F he must exert to get the block moving. (b) What is its acceleration once it starts to move, if that force is maintained? (OpenStax 5.18) **51.0 N, 0.720 m/s²**