Homework: Ch 5

1. Draw a free body diagram for the two situations below, where the direction of motion is shown by the arrow. Assume that there is a friction between the each block and the surface it is on.

2. In the real world, friction is all around us. What are three real world examples when having some friction (either kinetic or static) could be considered a good thing?

3. What is terminal velocity? Starting from Newton's second law derive the expression for terminal velocity shown in class.

4. Suppose you want to push your car, which has run out of gas, down the road to the gas station. Describe the motion in terms of the applied force, static force, and kinetic force on the car from when you first start to push the car until you get it moving at a constant velocity.

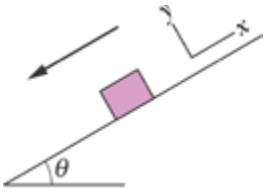
5. Playing near a road construction site, a child falls over a barrier and down onto a dirt slope that is angled downward at 35º to the horizontal. As the child slides down the slope, he has an acceleration that has a magnitude of 0.50 m/s^2 which is directed up the slope. What is the coefficient of kinetic friction between the child and the slope?

6. A worker pushes horizontally on a 35 kg crate with a force of magnitude 110 N. The coefficient of static friction between the crate the floor is 0.37. What is the value of $f_{s,max}$ under the circumstances? Does the crate move?

7. Although many ingenious schemes have been attributed to the building of the Great Pyramid, the stone blocks were probably hauled up the side of the pyramid by men pulling on ropes. Figure 6-5*a* represents a 2000 kg stone block in the process of being pulled up the finished (smooth) side of the Great Pyramid, which forms a plane inclined at angle $\theta = 52°$. The block is secured to a wood sled and is pulled by multiple ropes (only one is shown). The sled's track is lubricated with water to decrease the coefficient of static friction to 0.40. Assume negligible friction at the (lubricated) point where the ropes pass over the edge at the top of the side. If each man on top of the pyramid pulls with a (reasonable) force of 686 N, how many men are needed to put the block on the verge of moving?

8. A cylindrical aluminum rod, with an initial length of L_0 and radius r_0, is clamped in place at one end and then stretched by a machine pulling parallel to its length at its other end. Assuming that the rod's density (mass per unit volume) does not change, find the force magnitude that is required of the machine to decrease the radius to some value r_1. Let Young's modulus for aluminum be E_{Al}. (The yield strength is not exceeded.) State your answer in terms of the given variables, using π when appropriate.

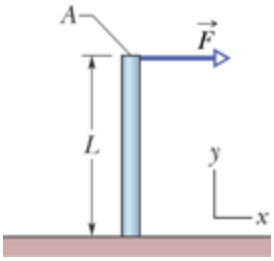
9. The figure to the right shows a 5.00 kg block sliding down a plane inclined at $\theta = 30.0^{\circ}$. The coefficient of kinetic friction between block and plane is 0.400. What is the block's acceleration?



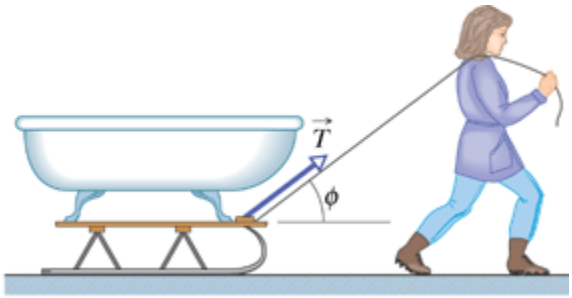
10. A horizontal aluminum rod 4.8 cm in diameter projects 5.3 cm from a wall. A 1200 kg object is suspended from the end of the rod. The shear modulus of aluminum is 2.5×10^{10} N/m^2. Neglecting the rod's mass, find (a) the shear stress on the rod and (b) the vertical deflection of the end of the rod.

11. If a falling cat reaches a first terminal speed of 97 km/h while it is tucked in and then stretches out, doubling A, how fast is it falling when it reaches a new terminal speed?

12. In the figure to the right, a force **F** of magnitude 12 N is applied parallel to the end face of a steel rod of length $L = 5.0$ cm. The face has an area of $A = 2.5 \times 10^{-4}$ m^2. The rod's other end is clamped in place. What are the shearing stress and the rod's deflection at its free end? What would be the the shearing stress and the rod's deflection at its free end if the rob was instead made out of brass? (Note: The Elastic Moduli Table is on page 180 of the text.)



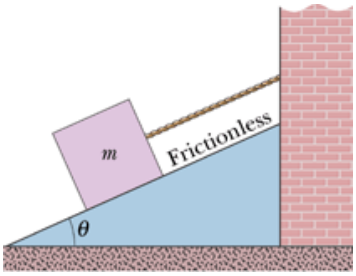
13. In the figure below, a woman pulls a loaded sled of mass $m = 75$ kg along a horizontal surface at constant velocity. The coefficient of kinetic friction between the runners and the snow is 0.10, and the angle ϕ is 42°.



14. Show that the acceleration of any object down an include that makes an angle of with the horizontal where friction behaves simply as $F_k = \mu_k N$ is given by

$$a = g(\sin\theta - \mu_k \cos\theta)$$

15. In the figure to the right, a cord holds a 15 kg block stationary on a plane inclined at an angle of = θ = 27º. Assuming that the coefficient of friction for the ramp is 0.25, what are the tension in the cord and the normal force on the block from the ramp?



16. When a glass bottle full of vinegar warms up, both the vinegar and the glass expand, but the vinegar expands significantly more with temperature than glass. The bottle will break it is was completely filled and tightly capped. Explain why, and also explain how a pocket of air above the vinegar would prevent the glass from breaking. (This is the function of the air above liquids in glass containers.)

17. Three blocks of masses m_1, m_2, and m_3 are connected together by massless cords with constant length. The coefficient of friction between m_1 and the surface on which it slides is given as μ. The pulley is also massless and frictionless. Determine the tension in the cord between block 2 and 3.