SI Workshop Problems #5: Newton's 2nd Law

1. As shown in figure 1, a 10 kg object on a horizontal surface is pulled by a 30 N force that makes an angle of θ.

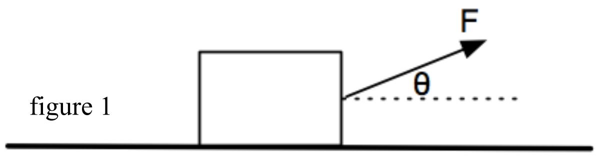

figure 1

   a. If θ = 30° above the horizontal and there is no friction, what is the acceleration of the object? [a=2.599m/s^2]
   b. If θ = 30° above the horizontal, what is the acceleration if there is a coefficient of kinetic friction of 0.3 between the object and the surface? [a=0.108 m/s^2]
   c. Assuming a coefficient of kinetic friction of 0.3, what would be the acceleration if the force were directed at 30° below the horizontal? [no acceleration as the friction force>F]
   d. If friction is eliminated what is the force needed to accelerate the block at the same rate as found in part (b), if the force acts in the same direction as in part (c) (30° below the horizontal)?
   e. Repeat part (d) but assume the coefficient of kinetic friction is 0.4. [F=60.5 N]

2. You are going at 60 mph and suddenly press on the brakes of your car. The wheels lock and you skid to a stop. If the skid marks are 300 ft long, what is the friction coefficient between the tires and the road? Would you say the road is normal, wet or icy? [need to find acc. first, μ=0.403]

3. A block is on a 30° incline with a coefficient of kinetic friction (μ_k) of 0.3 between the block and the incline.
   a. Find the acceleration of the block. [a=2.35 m/s^2]
   b. Find the magnitude of a force acting parallel to the incline that would move the block up the incline at the constant acceleration found in part (a). *(Give your answer in terms of the mass of the block, m.)* [F=9.80xm]
   c. Find the magnitude of a force acting parallel to the horizontal surface on which the incline is resting that would move the block up the incline at the constant acceleration found in part (a). *(Give your answer in terms of the mass of the block, m.)* [F=13.7xm]

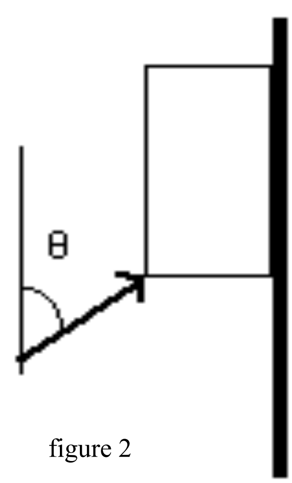

figure 2

4. Refer to figure 2.
   a. What force must you exert if you want to move a 10 lb block up a vertical wall at constant speed by pushing at an angle θ of 53° with the vertical? Assume μ_k = 0.3 between the block and the wall. [F=27.8 lbs.]
   b. What acceleration would you get if you added 7 lb to that

force? [a=8.1 ft/s^2]

c. At what angle (horizontal or vertical) must you exert a 15 lb force if you want to move a 5.0 lb block up a vertical wall at 1.5 ft/s^2? ($\mu_k = 0.3$) *Hint:* $\cos^2\theta + \sin^2\theta = 1$. [53.8° with the horizontal]

d. For what minimum angle θ (measured relative to the vertical) would you be unable to push the block at all, regardless of how large the force is? **[73.3° with the horizontal. 16.7° w/vertical]**