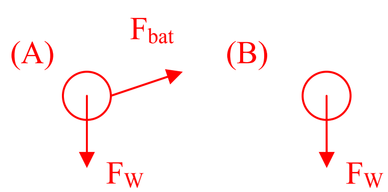
W3.09 Quick-Hit Newton's Law Problems 1 - KEY

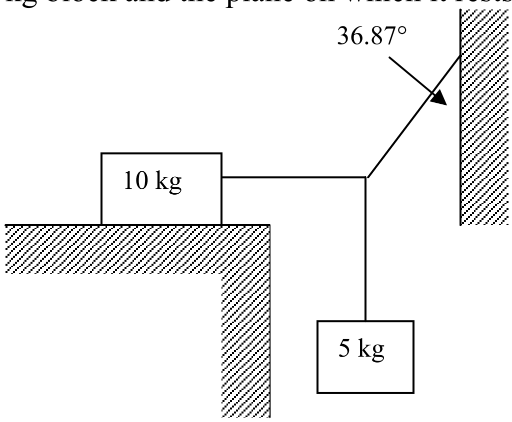
1. If the acceleration of a body is zero, are forces acting on it?
   Acceleration of zero means that the *net* force is zero, not that there are *no* forces.
2. Why do you push harder on the pedals of a bicycle when first starting out than when moving at a constant speed? There are two reasons.
   In order to accelerate from rest, the net force must be greater than zero. When moving at a constant speed, net force equals zero. When first starting to move, it is necessary to overcome static friction which is larger than kinetic friction.
3. When a golf ball is dropped on the pavement, it bounces back up. (A) Is a force need to make it bounce back up? (B) If so, what exerts the force? (C) How does this force compare to the golf ball's weight?
   Yes, the ground exerts a force larger than the weight of the ball to give it a net upward force.
4. Why might your foot hurt if you kick a heavy desk or a wall? Explain using the appropriate Newtonian Law.
   When you exert a force on an object, Newton's Third Law tells us that it exerts the same force back on you. Since your foot is much less massive than a heavy desk or wall, Newton's Second Law tells us that the acceleration of your foot is much larger than that of the desk or wall.
5. The force of gravity on a 2-kilogram rock is twice as great as that on a 1 kilogram rock. Why then doesn't the heavier rock fall faster?
   Acceleration is proportional to force and inversely proportional to mass.
   F_W = -mg (up as positive). F = ma. So -mg = ma, -g =a for both objects.
6. According to Newton's third law, each team in a tug of war pulls with equal force on the other team. What, then, determines which team will win?
   Friction force. The team with more friction with the surface will win.
7. Sketch the free-body diagram of a softball (A) at the moment it is hit by the bat, and again (B) after it has left the bat and is flying towards the outfield.



8. If the coefficient of kinetic friction between a 35-kilogram crate and the floor is 0.30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if μ_k is zero?
   105 N, 0 N
9. A cup of coffee on the dashboard of a car slides forward on the dash when the driver accelerates from 40 km/h to rest in 3.5 seconds or less, but not if she accelerates in a longer time. What is the coefficient of static friction between the cup and the dash?
   a_{max} = 40 kph/3.5s = 3.2 m/s^2, (y) $F_N = F_W$ = mg, (x) F_f = ma = μF_N ➔ μ = a/g = 0.32

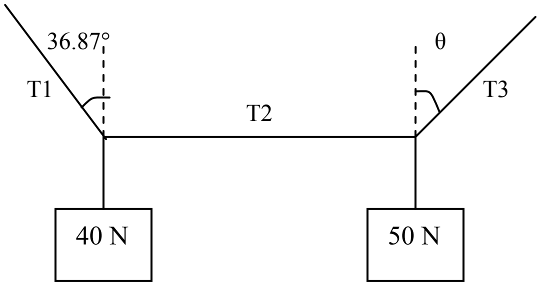
Review Problems (Challenging)

1. The system pictured below is in equilibrium, but begins to slip if ay additional mass is added to the 5.0-kg object. What is the coefficient of static friction between the 10-kg block and the plane on which it rests?



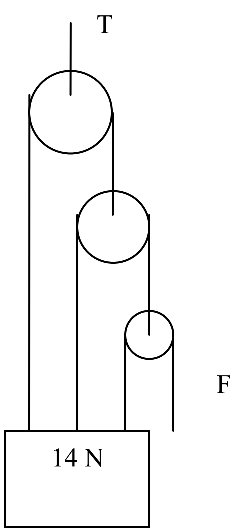
$\mu = 0.375$

2. The system below is in equilibrium with the string in the center "exactly" horizontal. Fine the angle θ and the tension in each string. (Hint: Do 2 free body diagrams, one at each knot.)



$T_1 = 50$ N
$T_2 = 30$ N
$T_3 = 58.3$ N
$\theta = 31°$

3. The force, ***F***, is just sufficient to hold the 14-N block and weightless pulleys in equilibrium. There is no appreciable friction between the cables and pulleys. Calculate the tension, ***T***, in the upper cable



T = 16 N