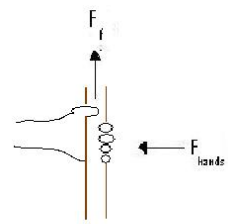
1 Selected Ch 5 Problems

1. Consider the problem of the person jumping out to a rope from Chapter 4 Problems. Assuming coefficient of friction between the hands and the rope is .6, what force must the hands exert on the rope?
Ans) Our free body diagram is our starting point, noting that the F_hands is point inwards towards the rope from all sides, not just towards the left.



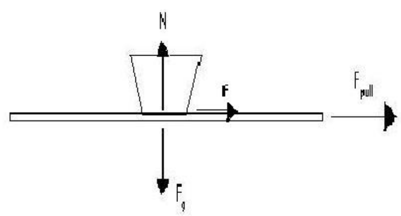
We already know the upwards force required from last time (which we then called the F_hands but now know is actually the F_f) is 6900N. Using $F_f = \mu N$ we can find the force the hands supply (which here is N). Therefore, $N = \frac{F_f}{\mu} = \frac{6900N}{.6} = 11500N$.

2. Consider the second problem from last time of a car sliding on ice. If the coefficient of friction on ice is .01, solve again for the acceleration of the car, this time including friction.
Ans) We only need to modify our free body diagram by adding in the friction force pointing up the slope, so I won't bother to redraw it. The friction force is given by, again, $F_f = \mu N$. To find this we must decompose our F_g into x-y components and then solve our equations in each direction.

$$
\begin{aligned}
y - components \\
\Sigma F = 0 \\
N - F_g * cos(20) = 0 \\
N = m * g * cos(20) \\
x - components \\
\Sigma F = m * a_x \\
-F_f + F_g * sin(20) = m * a_x \\
-\mu N + m * g * sin(20) = m * a_x \\
-(0.01)(mgcos(20)) + mgsin(20) = ma_x \\
a_x = g(sin(20) - .01cos(20)) = 3.24m/s^2
\end{aligned}
$$

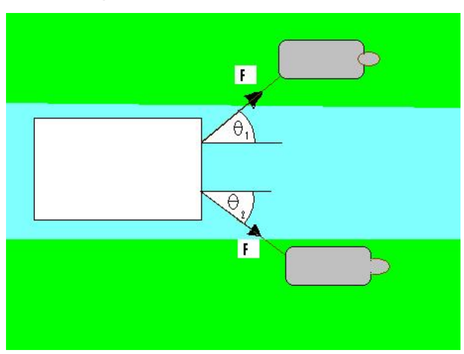
Note the basic problem solving strategy of looking at the free body diagram, breaking down the vectors into x-y components, and then plugging things into our equations.

3. You want to pull the trick of pulling a table cloth out from under a bowl of pudding. The bowl of pudding has a mass of .02kg and the coefficient of static friction between table cloth and bowl is .05. What force must you apply to the table cloth such that the bowl slides instead of flying off with the table cloth? Ans) Our problem solving strategy insists we start out with a free body diagram before anything else.



The force of friction acting on the bowl is given by $F_f = \mu N$ as normal. In the y-direction the acceleration is zero, so our sum of forces equation simply yields $N - F_g = 0; N = F_g = mg$. Our problem is that we want a force greater than the force due to friction. Think about this for a second, if we pull with a force less than friction, then friction will be strong enough to pull the bowl right along with it. However, friction, by this equation can only be so large, so if we provide a force greater than what friction can provide the table cloth will accelerate faster than the bowl of pudding and we can pull it out from underneath. So, by our equation we find friction to be $F_f = \mu mg = .05 * .02kg * 9.8m/s^2 = .0098N$. We only need provide a force larger than this to pull the tablecloth out.

4. In the old days it was common to travel up river by having pack animals pull the boat along while walking the shoreline as in this picture:



If the pack animals pull a barge with mass 2000kg and $\Theta_1 = 30.0^o; \Theta_2 = 45.0^o$, find the x and y components of the acceleration of the barge if each pack animal

can pull with a magnitude of 600N.
Ans) The first step is always to break everything down into x-y components, then plug what we know into our F=ma equation.

$$F_{1x} = F_1 cos(\Theta_1) = 600N cos(30.0^o) = 520N$$
$$F_{2x} = F_2 cos(\Theta_2) = 600N cos(45.0^o) = 424N$$
$$F_{1y} = F_1 sin(\Theta_1) = 600N sin(30.0^o) = 300N$$
$$F_{2y} = -F_2 sin(\Theta_2) = -600N sin(45.0^o) = -424N$$

Note that F_{2y} is negative because it points downward.
We now can do our sum of forces in each direction to find the total force components. And, knowing the total force we can find acceleration.

$$y - components$$
$$\Sigma F_y = F_{1y} + F_{2y} = 300N - 424N = -124N$$
$$\Sigma F_y = -124N = ma_y$$
$$a_y = \frac{-124N}{2000kg} = -.062m/s^2$$
$$x - components$$
$$\Sigma F_x = F_{1x} + F_{2x} = 520N + 424N = 944N$$
$$\Sigma F_x = 944N = ma_x$$
$$a_x = \frac{944N}{2000kg} = .472m/s^2$$