- I rearranged groups last weekend. I thought there may be some benefit to overlapping more often with students who signed up for the same final exam time-slot, for instance.
- worksheet: `positron.hep.upenn.edu/p8/files/ws14.pdf`
- 3 problems + 1 XC. Q3 is very tricky!
- Email **in advance** & file a CAN if you need to miss class, so that I can give you credit for making up work outside of class.
- Missing class (without a CAN) or frequent tardiness will in some way TBD be a factor in course grades.

$$F^K = \mu_K F^{\text{normal}} \qquad F^S \le \mu_S F^{\text{normal}} \qquad W = \vec{F} \cdot \Delta\vec{r}$$

F^{normal} is perpendicular to the surface and is as large as it needs to be to prevent the object from passing through the surface

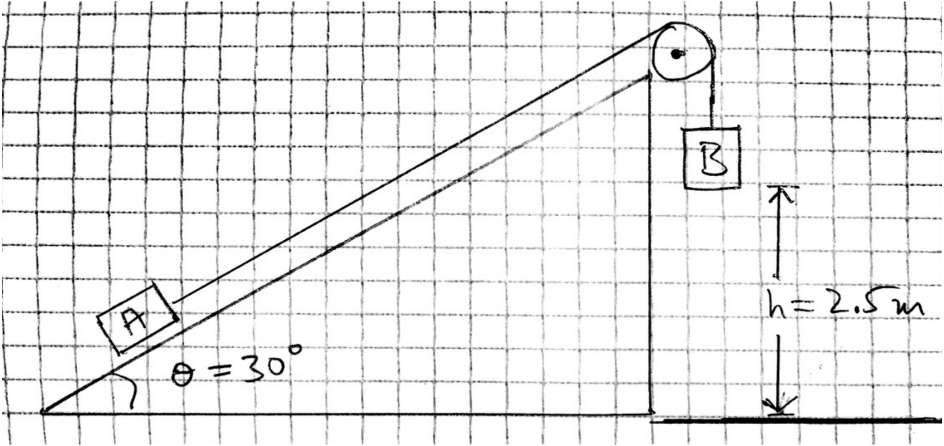
In today's problems, you usually need either to decompose gravity into "downhill" and "perpendicular" components, or else to decompose the pushing/pulling force into horizontal and vertical components. Remember that for an object that is either at rest or moving at constant velocity, forces along each axis sum (with proper signs) to zero. A careful FBD often helps.

1. A fried egg of mass *m* slides (at constant speed) down a Teflon frying pan tipped at an angle θ above the horizontal. [This only works if the angle θ is just right.] (a) Draw the free-body diagram for the egg. Be sure to include friction. (b) What is the "net force" (i.e. the vector sum of forces) acting on the egg? (c) How do these answers change if the egg is instead **slowing down** as it slides downhill on the surface of the pan?

2*. You have to specify the power output of a motor for a ski tow rope that will carry 15 passengers at a time, each having an average mass of 60 kg. The grade of the ski slope is 37° above horizontal, and the average coefficient of kinetic friction between skis and snow is 0.13. You decide that 2.2 m/s is a safe speed to be towed up the slope. What must the minimum power output of the motor be?

3*. Block A, of mass $m_A = 3.0\,\mathrm{kg}$, and block B, of mass $m_B = 9.0\,\mathrm{kg}$, are connected by a rope and pulley whose masses are negligible, as shown below. The friction coefficients between block A and the inclined plane (inclined at angle $\theta = 30^\circ$) are $\mu_K = 0.30$ and $\mu_S = 0.70$. Initially my hand holds block A at rest, so that the rope is taut and block B is suspended at height $h = 2.5\,\mathrm{m}$ above the platform. I remove my hand, thus releasing the blocks from rest. (a) Draw a FBD for block A and a FBD for block B the instant after I release the blocks. (b) At what time t after release does block B reach the platform? (c) Draw a FBD for block A the instant after block B has reached the platform (so the rope is no longer taut). (d) How far from the original starting position does block A travel up the inclined plane before it stops or turns around? (The plane is very long, so you do not need to worry about block A running into the pulley.) (e) What happens to block A after it reaches its maximum altitude? Does it stop, or does it start to slide downward? (f) Draw a FBD for block A for the scenario that you consider in part (e).

$m_A = 3.0\,\mathrm{kg}$, $m_B = 9.0\,\mathrm{kg}$, $\theta = 30^\circ$, $\mu_K = 0.30$, $\mu_S = 0.70$.
(a) FBD for A & for B just after release. (b) When does B hit platform? (c) FBD for A the instant after rope goes slack. (d) How far from the original starting position does block A go? (e) Does A stop, or slide downward? (f) FBD for A for scenario in (e).



(Extra point available for extraordinary diligence on this problem.)

4* (optional/XC). You have just inherited property in Vermont that would make an excellent ski resort. One of the ski slopes has a cliff on the other side of the hill, and this gives you a money-saving idea. Instead of a chair lift or motorized tow-rope, you decide to attach a pulley to the top of the cliff and then drape the tow-rope over the pulley, with one end of the rope temporarily secured at the base of the ski slope and a counterweight attached to the end that hangs over the edge of the cliff. The plan is to release the rope and pull two skiers (with the total mass of the pair kept between 100 and 200 kg) up the 400 m slope, which has an incline angle of 36.9°. You guess that customers get nervous if they move faster than 5.0 m/s, and you begin immediately to calculate the required properties of the counterweight. (I guess a 200 kg pair must make it up the hill, and a 100 kg pair must reach the top at final speed less than 5.0 m/s.) If you ignore friction altogether, is there any value for the mass of the counterweight that functions properly for the full range of skier masses? (The lightweight pair must not exceed the maximum speed, yet the more massive pair must make it up the hill.) If so, what range of masses works? If not, argue why not.