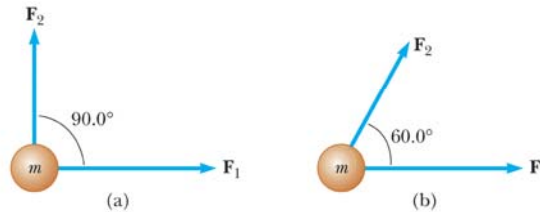
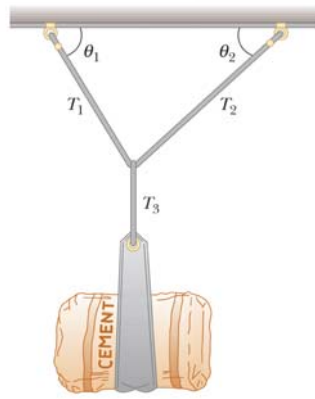


Physics 110
Spring 2006
Forces in 1- and 2-Dimensions

1. Two forces \mathbf{F}_1 and \mathbf{F}_2 acts on a 5kg mass. If the magnitudes of \mathbf{F}_1 and \mathbf{F}_2 are 20N and 15N respectively what are the accelerations of each of the masses below?



2. You stand on the seat of a chair and then hop off.
- During the time you are in flight down to the floor, the Earth is moving up toward you with an acceleration of what order of magnitude?
 - The Earth moves up through a distance of what order of magnitude?
3. The distance between two telephone poles is 50m. When a 1kg bird lands on the telephone wire halfway between the poles, the wire sags 0.2m.
- Draw a free body diagram of the bird.
 - How much tension does the bird produce in the wire?
4. A bag of cement of weight 325N hangs from three wires as shown below. Two of the wires make angles $\theta_1 = 60^\circ$ and $\theta_2 = 25^\circ$ with respect to the horizontal. If the system is in equilibrium, what are the three tension forces in the wire?



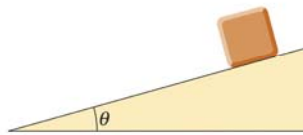
5. A fire/rescue helicopter carries a 620kg bucket of water at the end of a 20m long cable. As the aircraft flies back from a fire at constant speed of 40m/s, the cable makes an angle of 40° with respect to the vertical.

- What is the force due to air resistance on the bucket?
- After filling the bucket with water, the pilot returns to the fire at the same speed with the bucket now making a 7° angle with the vertical. What is the mass of the water in the bucket?

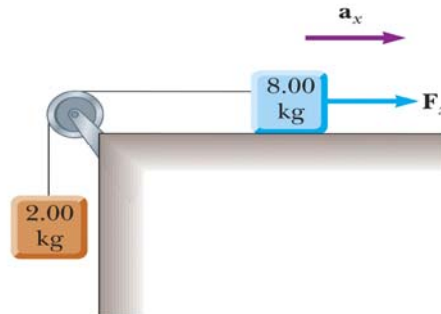


<http://www.fs.fed.us/r4/sc/fire/2005/photos/fallsckr/helicopter.jpg>

6. A block slides down a frictionless plane having an inclination of $\theta = 15^\circ$.
- If the block starts from rest, what is the acceleration of the block down the incline?
 - What is the speed of the block at the bottom of the incline if it travels a distance of 2m down the incline?
 - Suppose now that friction does exist between the block and incline. What is the new acceleration if the coefficient of kinetic friction, $\mu_k = 0.4$?
 - What is the new speed of the block at the bottom of the incline?



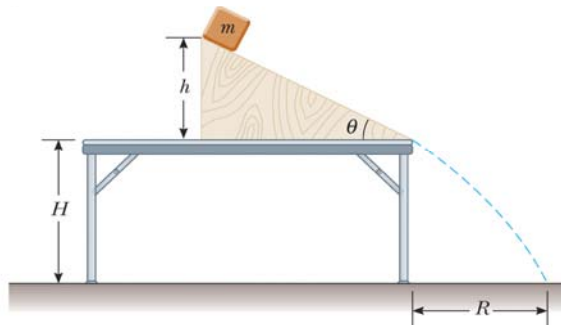
7. In the system shown below a horizontal force F_x acts on the 8kg mass. Consider two cases, one where the horizontal surface is frictionless and one where there is friction and the coefficient of kinetic friction is $\mu_k = 0.75$.
- For what values of F_x does the 2kg mass accelerate upwards?
 - For what values of F_x is the tension in the cord zero?
 - Plot the acceleration of the 8kg mass versus F_x . Include values of F_x from -100N to 100N.



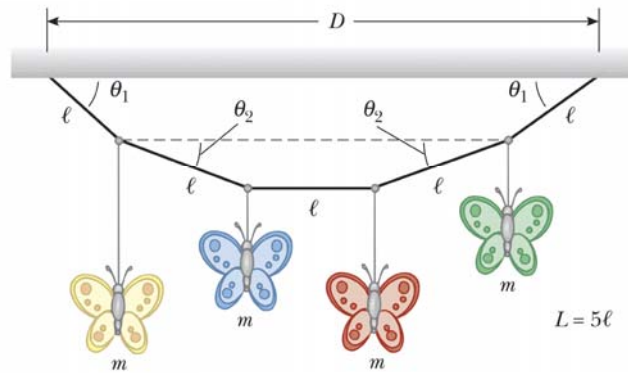
8. A woman at the airport is towing her 20kg suitcase at constant speed by pulling on a strap at an angle of θ above the horizontal. She pulls the strap with a force of 35N and the frictional force on the suitcase is 20N.
- What is the angle θ that the strap makes with the horizontal?
 - What normal force does the ground exert on the suitcase?



9. A boy drags his 60N sled at constant speed up a 15° hill. He does so by pulling with a 25N force on a rope attached to the sled. If the rope is inclined at 35° to the horizontal,
- What is the coefficient of kinetic friction between the sled and the snow?
 - At the top of the hill he jumps on the sled and slides down the hill. What is the magnitude of the acceleration of the boy and sled?
10. A block of mass $m = 2\text{kg}$ is released from rest $h = 0.5\text{m}$ from the surface of a table, at the top of a $\theta = 30^\circ$ incline. The frictionless incline is fixed on a table of height $H = 2\text{m}$.
- What is the acceleration of the block as it slides down the incline?
 - What is the velocity of the block as it leaves the incline?
 - How far from the table will the block land?
 - How much time has elapsed between the block was released and when it hits the floor?
 - Does the mass of the block affect any of the above calculations?
 - Redo the above calculations including a frictional force between the block and the incline with a coefficient of kinetic friction of $\mu_k = 0.57$.



11. A mobile hangs in a child's room formed by supporting four metal butterflies of equal mass m from a string of length L . The points of support are evenly spaced a distance l apart. The string forms an angle θ_1 with the ceiling at each point. The center section of the string is horizontal.
- What is the tension in each section of the string in terms of θ_1 , m and g ?
 - What is the angle θ_2 , in terms of θ_1 , that the sections of the string between the outside butterflies and the inside butterflies form with the horizontal.
 - For a cold spring night: Show that the distance D between the end points of the string is $D = \frac{L}{5} \left\{ 2 \cos \theta_1 + 2 \cos \left[\tan^{-1} \left(\frac{1}{2} \tan \theta_1 \right) \right] + 1 \right\}$.



12. Before 1960 it was believed that the maximum attainable coefficient of static friction for an automobile tire was less than 1. Then about 1962, three companies independently developed racing tires with coefficients of 1.6. Since then, tires have improved. According to the 1990 Guinness book of Records, the fastest time in which a piston-engine car initially at rest has covered a distance of $\frac{1}{4}$ mile is 4.96s. This record was set by Shirley Muldowney in September 1989.
- Assuming that the rear wheels lifted the front off the pavement, what minimum value of μ is necessary to achieve this record time?
 - Suppose Muldowney were able to double her engine power, keeping all other factors equal, how would this change the elapsed time?