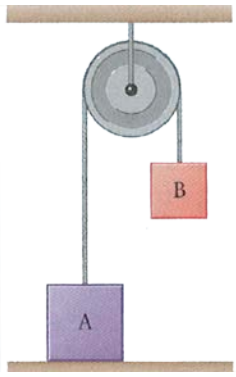
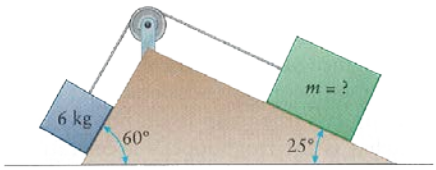
APPLYING NEWTON'S LAWS

1. **Pulley:** Box A weighs Mg and rests on a table. A rope that connects boxes A and B drapes over a pulley so that box B hangs above the table, as shown in the figure. The pulley is frictionless. What force the table exert on box A if box B weighs mg?

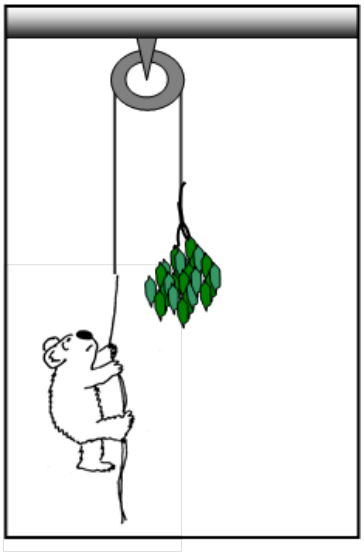


2. **Two inclines:** In figure the block on the left incline is M Find the mass of the block on the right incline so that the system is in equilibrium. All surfaces are frictionless



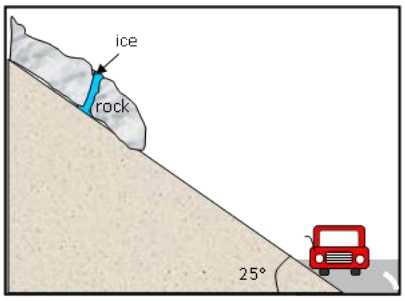
3. **Post Office Packages**: A new package moving system in the new, improved post office consists of a large circular disc (i.e. a turntable) which rotates once every 3.0 seconds at a constant speed in the horizontal plane. Packages are put on the outer edge of the turntable on one side of the room and taken off on the opposite side. The coefficient of static friction between the disc surface and a package is 0.80 while the coefficient of kinetic friction is 0.60. If this system is to work, what is the maximum possible radius of the turntable?

4. **Koala**: A 10 kg koala has a firm hold on a light rope that passes over a frictionless pulley and is attached to a 10 kg bunch of gum leaves. The koala looks upwards, sees the gum leaves, and starts to climb the rope to get them.



   (a) Draw a free-body diagram for the situation when the koala is stationary and one for when the koala is starting to climb the rope.
   (b) As the koala climbs, do the gum leaves move up, move down or remain at rest?
   (c) As the koala climbs, does the distance between the koala and the gum leaves decrease, increase or remain constant?
   (d) The koala releases her hold on the rope. What happens to the distance between the koala and the gum leaves as she is falling?
   (e) Before reaching the ground, the koala grabs the rope to stop her fall. Discuss what happens to the koala and gum leaves

5. **Landslide**: The section of rock shown on the Figure is held place by the frictional force between it and the hillside beneath. Water fills the crack and when it freezes overnight it expands and exerts a force on the rock, pushing it down along the slope. The angle between the hillside and the horizontal is 25°, and the coefficient of static friction between the rock and hill is μ_s. The coefficient of kinetic friction between the rock and hill is μ_k, and the rock has a mass is M.



   (a) Draw a diagram showing all the forces acting on the rock.

   (b) What force parallel to the hillside must the expanding water exert to move the rock?

   (c) If it exerts this force, such that the rock begins to slide, at what rate will it accelerate down the hill?

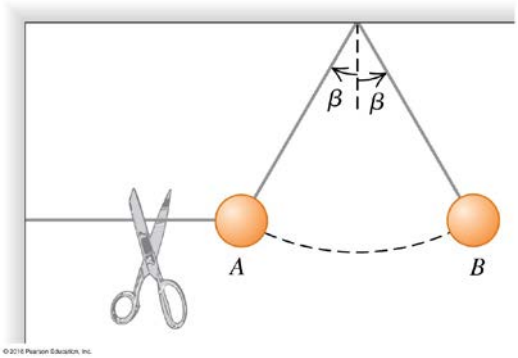
   (d) If there is a road L down-hill from the rock, what will be the velocity of the rock when it reaches the road?

6. **Moving a Box**: You are helping a friend move into a new apartment. A box mass is m needs to be moved to make room for a couch. You are taller than the box, so you reach down to push it at an angle of 50° from the horizontal. The coefficient of static friction between the box and the floor is μ_s and the coefficient of kinetic friction between the box and the floor is μ_k.

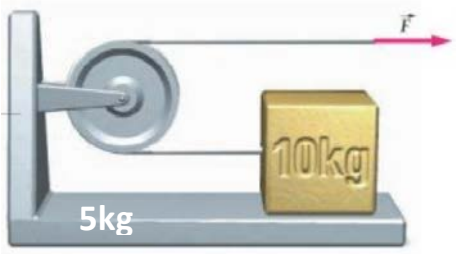
   (a) If you want to exert the minimum force necessary, how hard would you push to keep the box moving across the floor?

   (b) Suppose you bend your knees so that your push is horizontal. How hard would you push to keep the box moving across the floor?

7. **Ball on a String**: A ball is held at rest at position A, as shown in the figure, by two light strings. The horizontal string is cut, and the ball starts swinging as a pendulum. Position B is the farthest to the right that the ball can go as it swings back and forth. What is the ratio of the tension in the supporting string at B to its value at A before the string was cut?



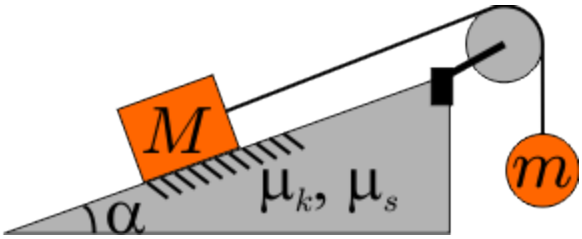
8. **Block on a Bracket**: A 10.0 kg block rests on a 5.0 kg bracket, as shown in the figure. The 5.0 kg bracket sits on a frictionless surface. The coefficients of friction between the 10.0 kg block and the bracket on which it rests are μ_s = 0.40 and μ_k = 0.30.



   (a) What is the maximum force F that can be applied if the 10.0 kg block is not to slide on the bracket?

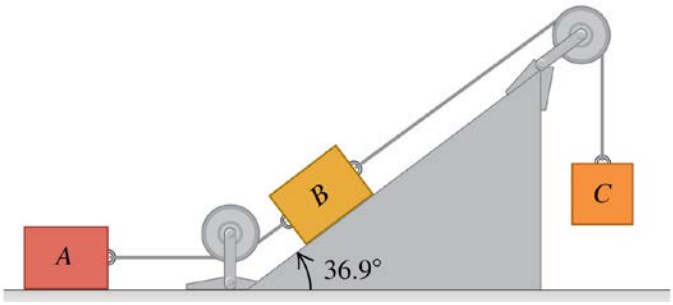
   (b) What is the corresponding acceleration of the 5.0 kg bracket?

9. **Box and ball:** Box of mass M is at rest on rough incline surface. The incline has angle α with horizontal. Ball on mass m is connected to the box via massless rope passing over frictionless massless pulley as it is shown on the figure. Coefficient of static and kinetic friction between incline and the box are μ_s and μ_k correspondently. It is known, that $\mu_s > \mu_k$ and if something will help box start to move, it will not stop moving until it reach the pulley. Answer question below in terms of $g, \alpha, M, m, \mu_s, \mu_k$ (not all may be necessary).



   (a) Box is at rest. Draw free body diagram of the box and the ball
   (b) Box is at rest. Find tension in the rope.
   (c) Box is at rest. Find friction force acting on the box
   (d) In this part of the problem, block M is moving up the incline. What is the acceleration of the box?
   (e) Find tension force in previous part.

10. **Blocks on an Incline**: Blocks A, B, and C are placed as shown in the figure and connected by ropes of negligible mass. Both A and B weigh m each, and the coefficient of kinetic friction between each block and the surface is μ. Block C descends with constant velocity.



   (a) Draw separate free-body diagrams showing the forces acting on A and on B.
   (b) Find the tension in the rope connecting blocks A and B.
   (c) What is the weight of block C?
   (d) If the rope connecting A and B were cut, what would be the acceleration of C?