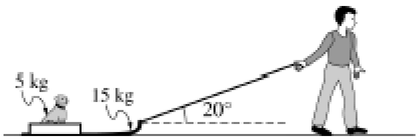


1. A child pulls a 15kg sled containing a 5kg dog along a straight path on a horizontal surface. He exerts a force of a 55N on the sled at an angle of 20º above the horizontal. The coefficient of friction between the sled and the surface is 0.22.

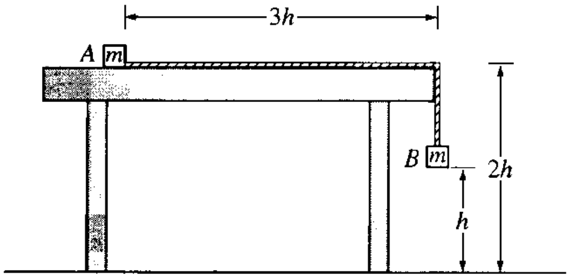
(a) Draw and label a free-body diagram for the sled-dog system as it is pulled along the surface.
(b) Calculate the normal force on the system.
(c) Calculate the acceleration of the system.
(d) Calculate the time it will take the system to slide 3.0m.
(e) At some later time, the dogs rolls of the side of the sled. The child continues to pull with the same force. Sketch a graph of speed *v* versus time *t* for the sled. Include both the sled's travel with and without the dog on the sled. Indicate with the symbol t_r the time at which the dog rolls off.

2. An empty sled of mass 25 kg slides down a muddy hill with a constant speed of 2.4 m/s. The slope of the hill is inclined at an angle of 15º with the horizontal as shown in the figure above.

a) Calculate the time it takes the sled to go 21 m down the slope.
b) Calculate the coefficient of kinetic friction between the sled and the muddy surface of the slope.
c) The sled reaches the bottom of the slope and continues on the horizontal ground. Assume the same coefficient of friction.

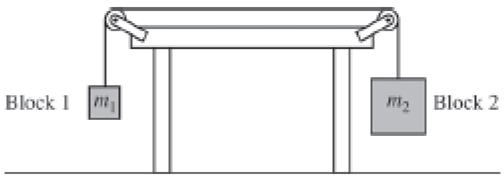
   i. In terms of velocity and acceleration, describe the motion of the sled as it travels on the horizontal ground.
   ii. Sketch a graph of speed *v* versus time *t* for the sled. Include both the sled's travel down the slope and across the horizontal ground. Clearly indicate with the symbol t_l the time at which the sled leaves the slope.

d) Suppose the same sled is given an initial push, slides up the ramp, and then slides back down the ramp. Is the magnitude of the acceleration greater as it slides up or as it slides down? Explain.



3. Two small blocks, each of mass m, are connected by a string of constant length 4h and negligible mass. Block A is placed on a smooth tabletop as shown above, and block B hangs over the edge of the table. The tabletop is a distance *2h* above the floor. Block B is then released from rest at a distance h above the floor at time t = 0. Express all algebraic answers in terms of h, m, and g.

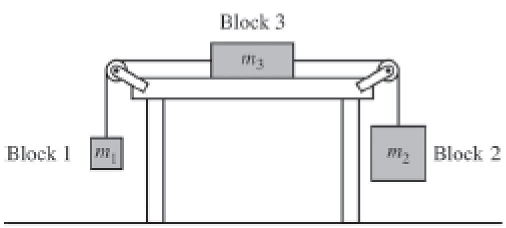
a. Determine the acceleration of block B as it descends.
b. Block B strikes the floor and does not bounce. Determine the time t_1 at which block B strikes the floor.
c. Describe the motion of block A from time t = 0 to the time when block B strikes the floor.
d. Describe the motion of block A from the time block B strikes the floor to the time block A leaves the table.
e. Determine the distance between the landing points of the two blocks.
f. If the mass of the rope was not negligible, what would happen to the answer to (e)? Explain.



Note: Figure not drawn to scale.

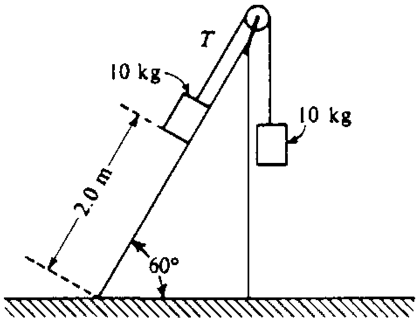
4. Two blocks are connected by a string of negligible mass that passes over massless pulleys that turn with negligible friction, as shown in the figure above. The mass m_2 of block 2 is greater than the mass m_1 of block 1. The blocks are released from rest.

(a) Draw free-body diagrams showing and labeling the forces (not components) exerted on each block. Draw the relative lengths of all vectors to reflect the relative magnitude of all the forces.
(b) Derive the magnitude of the acceleration of block 2. Express your answer in terms of m_1, m_2, and g.
(c) Block 3 of mass m_3 is added to the system, as shown below. There is no friction between block 3 and the table.



Note: Figure not drawn to scale.

(d) Indicate whether the magnitude of the acceleration of block 2 is now larger, smaller, or the same as in the original two-block system. Explain how you arrived at your answer.



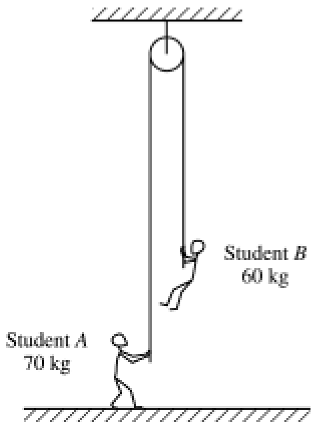
5. Two 10-kilogram boxes are connected by a massless string that passes over a massless frictionless pulley as shown above. The boxes remain at rest, with the one on the right hanging vertically and the one on the left 2.0 meters from the bottom of an inclined plane that makes an angle of 60° with the horizontal. The coefficients of kinetic friction and static friction between the left-hand box and the plane are 0.15 and 0.30, respectively.

You may use $g = 10\ m/s^2$, sin 60° = 0.87, and cos 60° = 0.50.

a. What is the tension T in the string?
b. Draw and label all the forces acting on the box that is on the plane.
c. Determine the magnitude of the frictional force acting on the box on the plane.
d. What is wrong with the statement, "The two blocks would remain stationary even if there was no friction, because they have the same mass and would balance each other out."?

The string is then cut and the left-hand box slides down the inclined plane.

e. Determine the speed at which it strikes the floor.



6. A rope of negligible mass passes over a pulley of negligible mass attached to the ceiling, as shown above. One end of the rope is held by Student A of mass 70 kg, who is at rest on the floor. The opposite end of the rope is held by Student B of mass 60 kg, who is suspended at rest above the floor.

(a) Draw and label free-body diagrams for both students A and B.
(b) Calculate the magnitude of the force exerted by the floor on Student A.

Student B now climbs up the rope at a constant acceleration of 0.25 m/s^2 with respect to the floor.

(c) Calculate the tension in the rope while Student B is accelerating.

(d) As Student B is accelerating, is Student A pulled upward off the floor? Justify your answer.

(e) With what minimum acceleration must Student B climb up the rope to lift Student A upward off the floor?