

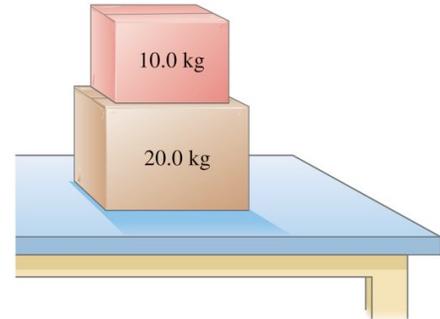
CHAPTER 4: Dynamics: Newton's Laws of Motion

Problems

4-4 to 4-6 Newton's Laws, Gravitational Force, Normal Force

1. (I) What force is needed to accelerate a child on a sled (total mass = 60.0 kg) at 1.25 m/s^2 ?

5. (II) A 20.0-kg box rests on a table. (a) What is the weight of the box and the normal force acting on it? (b) A 10.0-kg box is placed on top of the 20.0-kg box, as shown in Fig. 4-38. Determine the normal force that the table exerts on the 20.0-kg box and the normal force that the 20.0-kg box exerts on the 10.0-kg box.



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6. (II) What average force is required to stop an 1100-kg car in 8.0 s if the car is traveling at 95 km/h?

12. (II) A 12.0-kg bucket is lowered vertically by a rope in which there is 163 N of tension at a given instant. What is the acceleration of the bucket? Is it up or down?

17. (II) (a) What is the acceleration of two falling sky divers (mass 132 kg including parachute) when the upward force of air resistance is equal to one-fourth of their weight? (b) After popping open the parachute, the divers descend leisurely to the ground at constant speed. What now is the force of air resistance on the sky divers and their parachute? See Fig. 4-39.

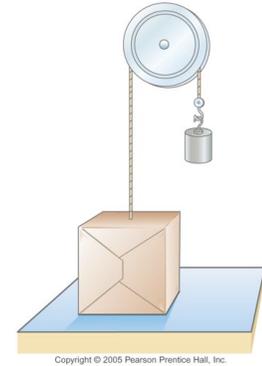


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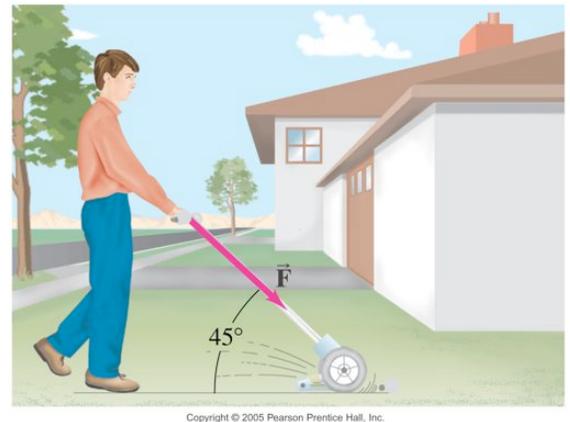
18. (III) A person jumps from the roof of a house 3.9-m high. When he strikes the ground below, he bends his knees so that his torso decelerates over an approximate distance of 0.70 m. If the mass of his torso (excluding legs) is 42 kg, find (a) his velocity just before his feet strike the ground, and (b) the average force exerted on his torso by his legs during deceleration.

4-7 Newton's Laws and Vectors

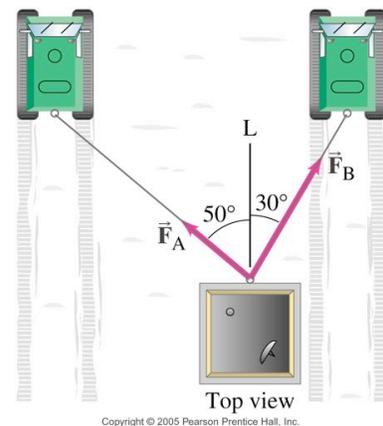
19. (I) A box weighing 77.0 N rests on a table. A rope tied to the box runs vertically upward over a pulley and a weight is hung from the other end (Fig. 4-40). Determine the force that the table exerts on the box if the weight hanging on the other side of the pulley weighs (a) 30.0 N, (b) 60.0 N, and (c) 90.0 N.



26. (II) A person pushes a 14.0-kg lawn mower at constant speed with a force of $F = 88.0$ N directed along the handle, which is at an angle of 45.0° to the horizontal (Fig. 4-45). (a) Draw the free-body diagram showing all forces acting on the mower. Calculate (b) the horizontal friction force on the mower, then (c) the normal force exerted vertically upward on the mower by the ground. (d) What force must the person exert on the lawn mower to accelerate it from rest to 1.5 m/s in 2.5 seconds, assuming the same friction force?

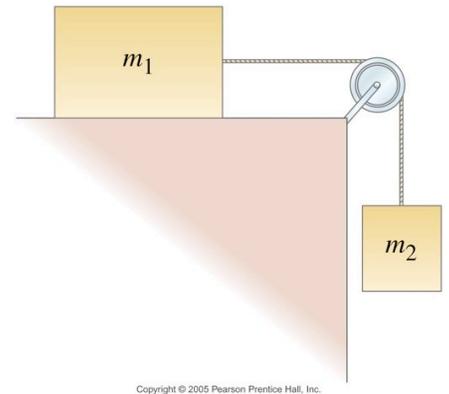


27. (II) Two snowcats tow a housing unit to a new location at McMurdo Base, Antarctica, as shown in Fig. 4-46. The sum of the forces \vec{F}_A and \vec{F}_B exerted on the unit by the horizontal cables is parallel to the line L, and $F_A = 4500$ N. Determine F_B and the magnitude of $\vec{F}_A + \vec{F}_B$.

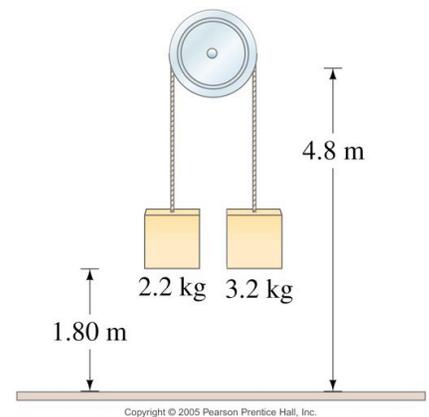


30. (II) At the instant a race began, a 65-kg sprinter exerted a force of 720 N on the starting block at a 22° angle with respect to the ground. (a) What was the horizontal acceleration of the sprinter? (b) If the force was exerted for 0.32 s, with what speed did the sprinter leave the starting block?

31. (II) Figure 4–49 shows a block (mass m_1) on a smooth horizontal surface, connected by a thin cord that passes over a pulley to a second block (m_2), which hangs vertically. (a) Draw a free-body diagram for each block, showing the force of gravity on each, the force (tension) exerted by the cord, and any normal force. (b) Apply Newton’s second law to find formulas for the acceleration of the system and for the tension in the cord. Ignore friction and the masses of the pulley and cord.



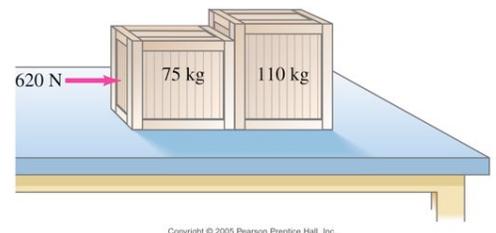
34. (III) The two masses shown in Fig. 4–52 are each initially 1.80 m above the ground, and the massless frictionless pulley is 4.8 m above the ground. What maximum height does the lighter object reach after the system is released? [Hint: First determine the acceleration of the lighter mass and then its velocity at the moment the heavier one hits the ground. This is its “launch” speed. Assume it doesn’t hit the pulley.]



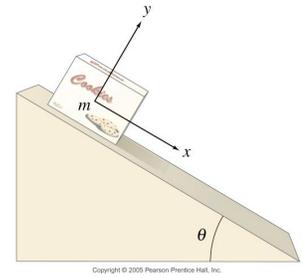
4–8 Newton’s Laws with Friction; Inclines

41. (II) A 15.0-kg box is released on a 32° incline and accelerates down the incline at 0.30 m/s^2 . Find the friction force impeding its motion. What is the coefficient of kinetic friction?

48. (II) Two crates, of mass 75 kg and 110 kg, are in contact and at rest on a horizontal surface (Fig. 4–54). A 620-N force is exerted on the 75-kg crate. If the coefficient of kinetic friction is 0.15, calculate (a) the acceleration of the system, and (b) the force that each crate exerts on the other. (c) Repeat with the crates reversed.



53. (II) A carton is given an initial speed of 3.0 m/s up the 22.0° plane shown in Fig. 4–55. (a) How far up the plane will it go? (b) How much time elapses before it returns to its starting point? Ignore friction.



57. (II) Piles of snow on slippery roofs can become dangerous projectiles as they melt. Consider a chunk of snow at the ridge of a roof with a pitch of 30° . (a) What is the minimum value of the coefficient of static friction that will keep the snow from sliding down? (b) As the snow begins to melt, the coefficient of static friction decreases and the snow eventually slips. Assuming that the distance from the chunk to the edge of the roof is 5.0 m and the coefficient of kinetic friction is 0.20 , calculate the speed of the snow chunk when it slides off the roof. (c) If the edge of the roof is 10.0 m above ground, what is the speed of the snow when it hits the ground?
64. (III) (a) Suppose the coefficient of kinetic friction between m_1 and the plane in Fig. 4–57 is $\mu_k = 0.15$, and that $m_1 = m_2 = 2.7 \text{ kg}$. As m_2 moves down, determine the magnitude of the acceleration of m_1 and m_2 , given $\theta = 25^\circ$. (b) What smallest value of μ_k will keep this system from accelerating?

