Applied Physics

PH-101 Fall 2024

Assignment 3; Chapter 4-5

Deadline of submission: 14.10.2024

Q1. You walk into an elevator, step onto a scale, and push the“up” button. You recall that your normal weight is 625 N. Draw a free-body diagram. (a) When the elevator has an upward acceleration of magnitude 2.50 m/s2, what does the scale read? (b) If you hold a 3.85-kg package by a light vertical string, what will be the tension in this string when the elevator accelerates as in part (a)?

Q2. A dockworker applies a constant horizontal force of 80.0 N to a block of ice on a smooth horizontal floor. The frictional force is negligible. The block starts from rest and moves 11.0 m in 5.00 s. (a) What is the mass of the block of ice? (b) If the worker stops pushing at the end of 5.00 s, how far does the block move in the next 5.00 s?

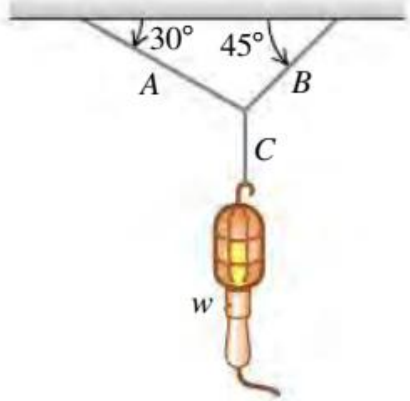
Q3. The upward normal force exerted by the floor is 620 N on an elevator passenger who weighs 650 N. What are the reaction forces to these two forces? Is the passenger accelerating? If so, what are the magnitude and direction of the acceleration?

Q4. A large box containing your new computer sits on the bed of your pickup truck. You are stopped at a red light. When the light turns green, you stomp on the gas and the truck accelerates. To your horror, the box starts to slide toward the back of the truck. Draw clearly labeled free-body diagrams for the truck and for the box. Indicate pairs of forces, if any, that are third-law action–reaction pairs. (The horizontal truck bed is *not* frictionless.)

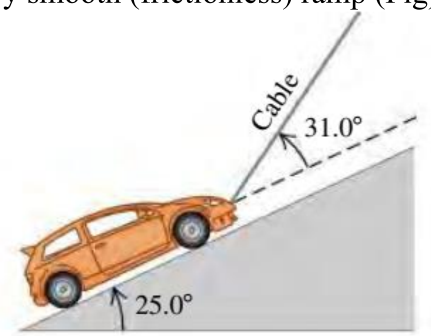
Q5. The fastest pitched baseball was measured at 46 m/s. A typical baseball has a mass of 145 g. If the pitcher exerted his force (assumed to be horizontal and constant) over a distance of 1.0 m, (a) what force did he produce on the ball during this record-setting pitch? (b) Draw free-body diagrams of the ball during the pitch and just *after* it left the pitcher’s hand.

Q6. Boxes A and B are connected to each end of a light vertical rope (**Fig.**). A constant upward force F = 80.0 N is applied to box A. Starting from rest, box B descends 12.0 m in 4.00 s. The tension in the rope connecting the two boxes is 36.0 N. What are the masses of (a) box B, (b) box A?

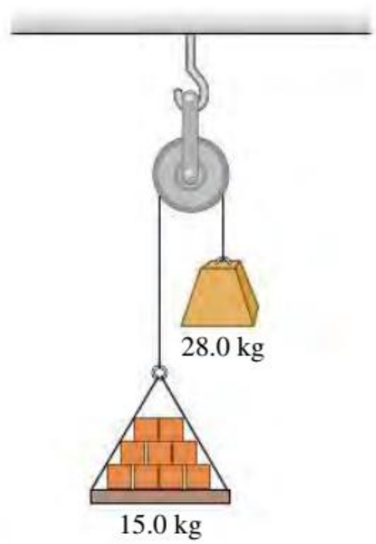
Q7. Find the tension in each cord in Fig. if the weight of the suspended object is w.



Q8. A 1130-kg car is held in place by a light cable on a very smooth (frictionless) ramp (Fig). The cable makes an angle of 31.0° above the surface of the ramp, and the ramp itself rises at 25.0° above the horizontal. (a) Draw a free-body diagram for the car. (b) Find the tension in the cable. (c) How hard does the surface of the ramp push on the car?



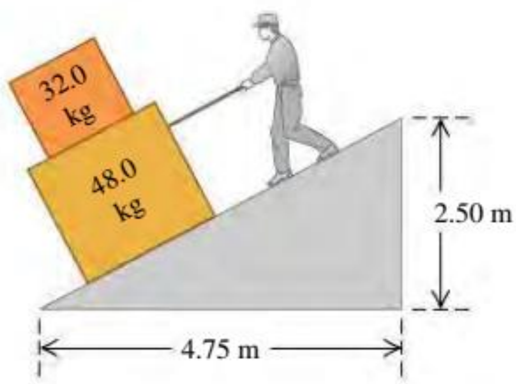
Q9. A 15.0-kg load of bricks hangs from one end of a rope that passes over a small, frictionless pulley. A 28.0-kg counterweight is suspended from the other end of the rope (**Fig**). The system is released from rest. (a) Draw two free-body diagrams, one for the load of bricks and one for the counterweight. (b) What is the magnitude of the upward acceleration of the load of bricks? (c) What is the tension in the rope while the load is moving? How does the tension compare to the weight of the load of bricks? To the weight of the counterweight?



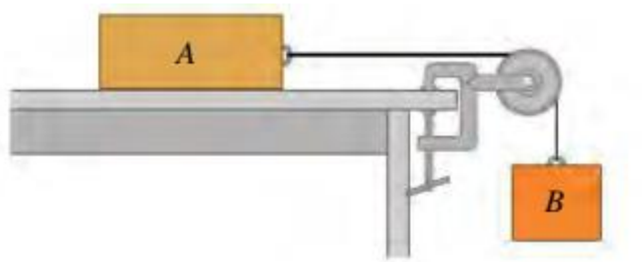
Q10. A 550-N physics student stands on a bathroom scale in an elevator that is supported by a cable. The combined mass of student plus elevator is 850 kg. As the elevator starts moving, the scale reads 450 N. (a) Find the acceleration of the elevator (magnitude and direction). (b) What is the acceleration if the scale reads 670 N? (c) If the scale reads zero, should the student worry? Explain. (d) What is the tension in the cable in parts (a) and (c)?

Q11. A stockroom worker pushes a box with mass 16.8 kg on a horizontal surface with a constant speed of 3.50 m/s. The coefficient of kinetic friction between the box and the surface is 0.20. (a) What horizontal force must the worker apply to maintain the motion? (b) If the force calculated in part (a) is removed, how far does the box slide before coming to rest?

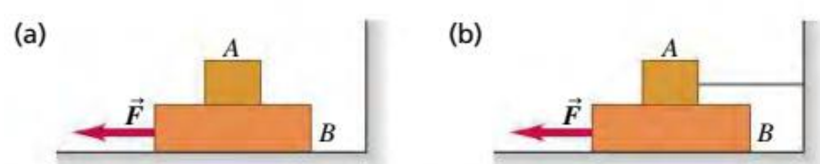
Q12. You are lowering two boxes, one on top of the other, down a ramp by pulling on a rope parallel to the surface of the ramp (**Fig.**). Both boxes move together at a constant speed of 15.0 cm/s. The coefficient of kinetic friction between the ramp and the lower box is 0.444, and the coefficient of static friction between the two boxes is 0.800. (a) What force do you need to exert to accomplish this? (b) What are the magnitude and direction of the friction force on the upper box?



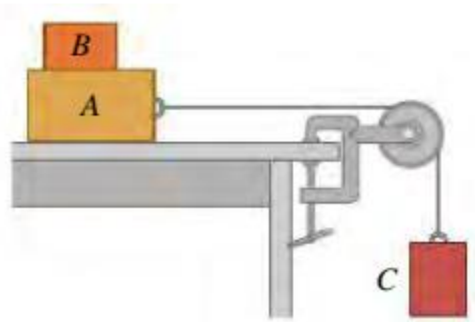
Q13. Consider the system shown in **Fig**. Block *A* weighs 45.0 N, and block *B* weighs 25.0 N. Once block *B* is set into downward motion, it descends at a constant speed. (a) Calculate the coefficient of kinetic friction between block *A* and the tabletop. (b) A cat, also of weight 45.0 N, falls asleep on top of block *A*. If block *B* is now set into downward motion, what is its acceleration (magnitude and direction)?



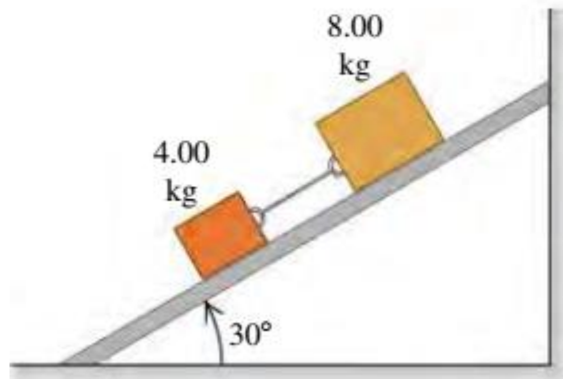
Q14 . Block *A* in **Fig.** weighs 1.20 N, and block *B* weighs 3.60 N. The coefficient of kinetic friction between all surfaces is 0.300. Find the magnitude of the horizontal force ***F*** necessary to drag block *B* to the left at constant speed (a) if *A* rests on *B* and moves with it (Fig a), (b) if *A* is held at rest (Fig. b).



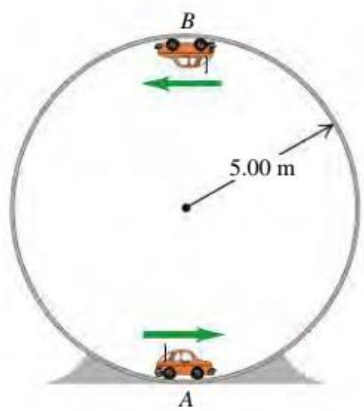
Q15. Block *B*, with mass 5.00 kg, rests on block *A*, with mass 8.00 kg, which in turn is on a horizontal tabletop (**Fig**). There is no friction between block *A* and the tabletop, but the coefficient of static friction between blocks *A* and *B* is 0.750. A light string attached to block *A* passes over a frictionless, massless pulley, and block *C* is suspended from the other end of the string. What is the largest mass that block *C* can have so that blocks *A* and *B* still slide together when the system is released from rest?



Q16. Two blocks, with masses 4.00 kg and 8.00 kg, are connected by a string and slide down a 30.0° inclined plane (Fig). The coefficient of kinetic friction between the 4.00-kg block and the plane is 0.25; that between the 8.00-kg block and the plane is 0.35. Calculate (a) the acceleration of each block and (b) the tension in the string. (c) What happens if the positions of the blocks are reversed, so that the 4.00-kg block is uphill from the 8.00-kg block?



Q17. A small remote-controlled car with mass 1.60 kg moves at a constant speed of v = 12.0 m>s in a track formed by a vertical circle inside a hollow metal cylinder that has a radius of 5.00 m (**Fig**). What is the magnitude of the normal force exerted on the car by the walls of the cylinder at (a) point *A* (bottom of the track) and (b) point *B* (top of the track)?



Q18. The "Giant Swing" at a county fair consists of a vertical central shaft with a number of horizontal arms attached at its upper end. Each arm supports a seat suspended from a cable 5.00 m long, and the upper end of the cable is fastened to the arm at a point 3.00 m from the central shaft (Fig). (a) Find the time of one revolution of the swing if the cable supporting a seat makes an angle of 30.0° with the vertical. (b) Does the angle depend on the weight of the passenger for a given rate of revolution?