Lecture 10

Physics 160-02 Spring 2017

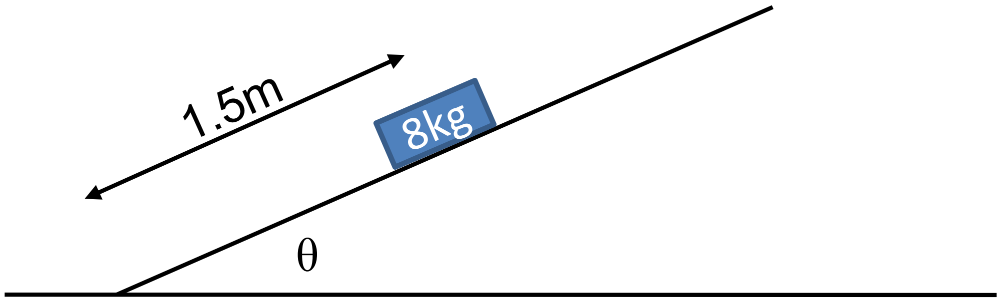
Douglas Fields

Problem 5.20

5.20. A 8.00-kg block of ice, released from rest at the top of a 1.50-m-long frictionless ramp, slides downhill, reaching a speed of 2.50 m/s at the bottom. (a) What is the angle between the ramp and the horizontal? (b) What would be the speed of the ice at the bottom if the motion were opposed by a constant friction force of 10.0 N parallel to the surface of the ramp?

Two Problems:

1) 1D motion with acceleration
2) Newton's Second Law



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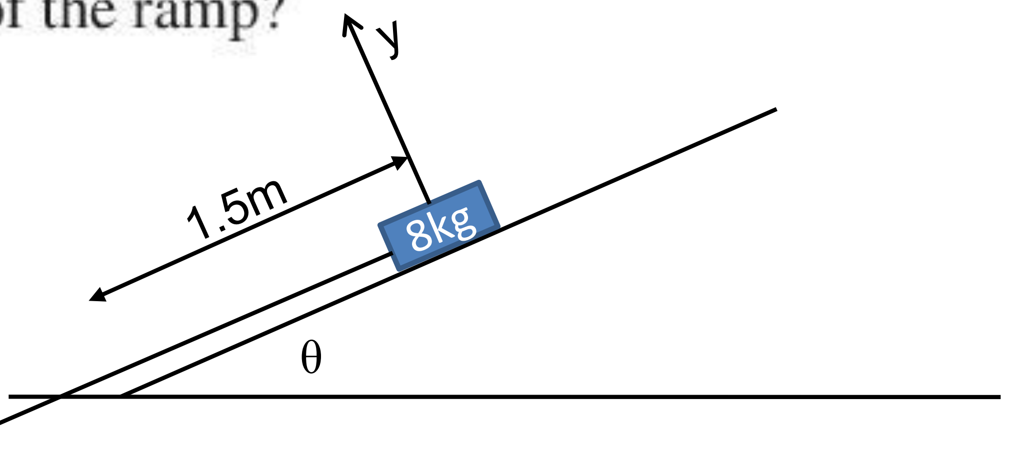

1) 1D motion with acceleration

x_0 = 0m
x_f = 1.5m
v_{x0} = 0m/s
v_{xf} = 2.5m/s
a_x = ?
t = ?

$$v_{xf}^2 = v_{x0}^2 + 2a_x(x_f - x_0)$$

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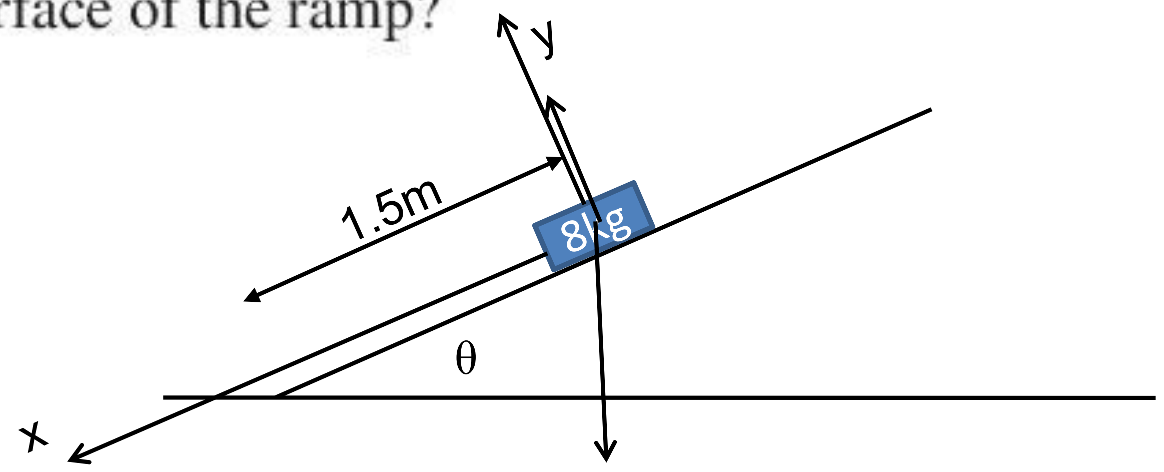
2) Newton's Second Law

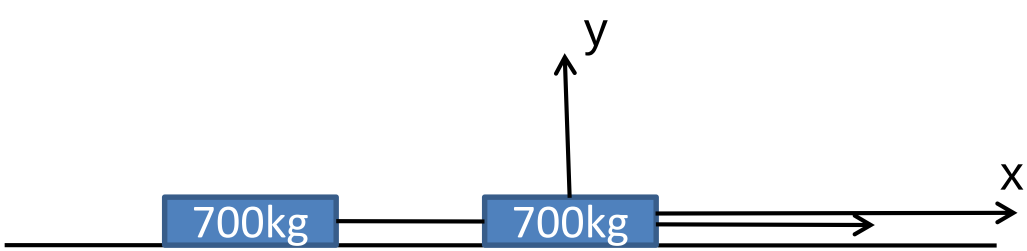
a_x = from last slide

$$\sum F_x = ma_x$$



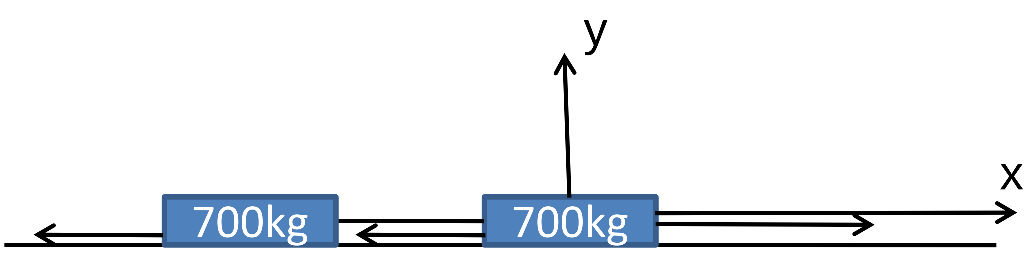
Problem 5.22

5.22. Runway Design. A transport plane takes off from a level landing field with two gliders in tow, one behind the other. The mass of each glider is 700 kg, and the total resistance (air drag plus friction with the runway) on each may be assumed constant and equal to 2500 N. The tension in the towrope between the transport plane and the first glider is not to exceed 12,000 N. (a) If a speed of 40 m/s is required for takeoff, what minimum length of runway is needed? (b) What is the tension in the towrope between the two gliders while they are accelerating for the takeoff?



Problem 5.22

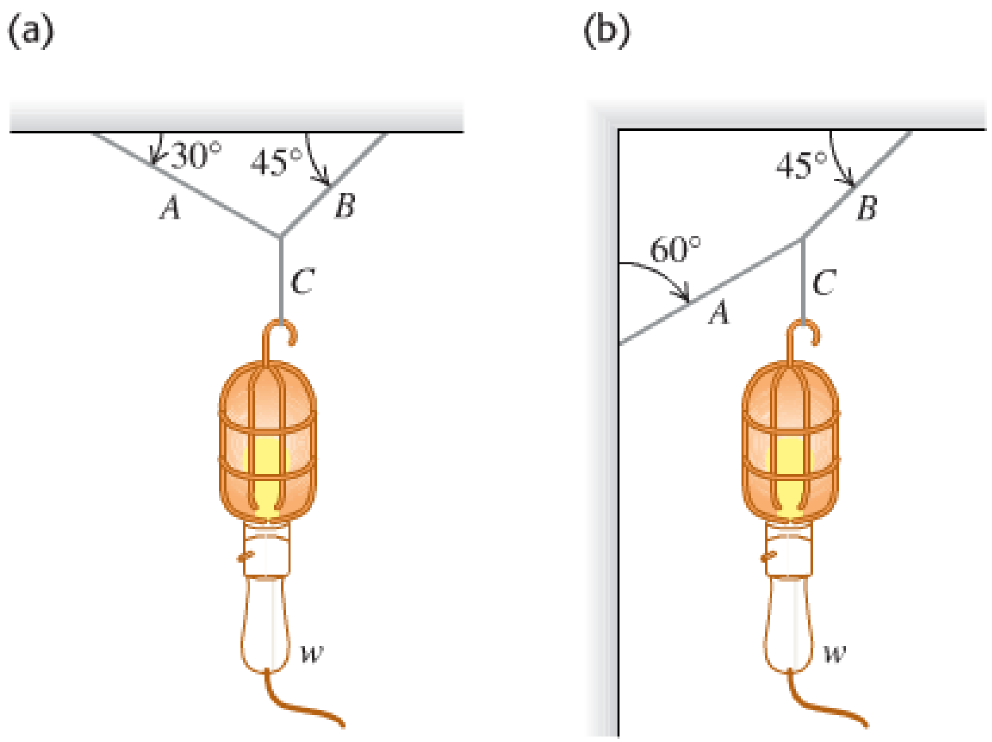
- First, think of the two planes as one load on the tether line…
- Then, use Newton's 2nd Law to calculate the maximum acceleration that the tether rope will stand.
- From that acceleration, find the minimum runway distance.



Problem 5.9

5.9. Find the tension in each cord in Fig. 5.44 if the weight of the suspended object is w.

Figure **5.44** Exercise 5.9.



Analyzing Forces

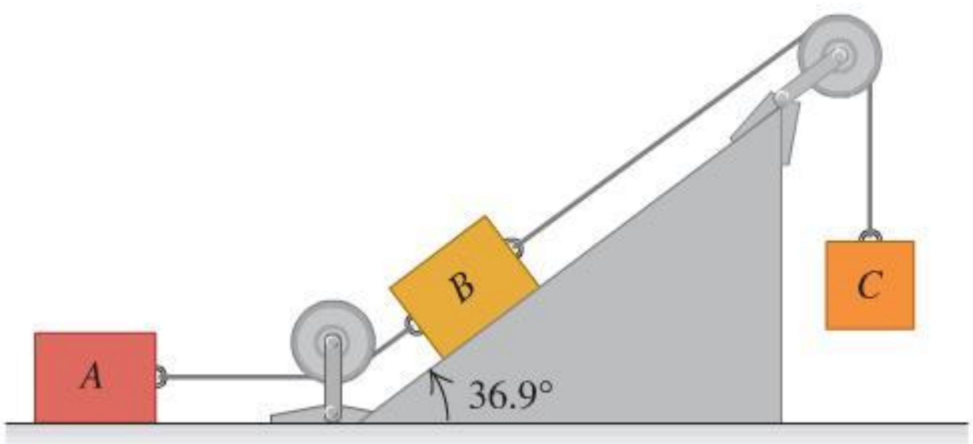
- Equilibrium in an inertial frame
- Acceleration in an inertial frame
- Equilibrium in a non-inertial frame

Problem 5.45

- Equilibrium in an inertial frame

5.45. Blocks A, B, and C are placed as in Fig. 5.56 and connected by ropes of negligible mass. Both A and B weigh 25.0 N each, and the coefficient of kinetic friction between each block and the surface is 0.35. Block C descends with constant velocity. (a) Draw two 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?

Figure 5.56 Exercise 5.45.

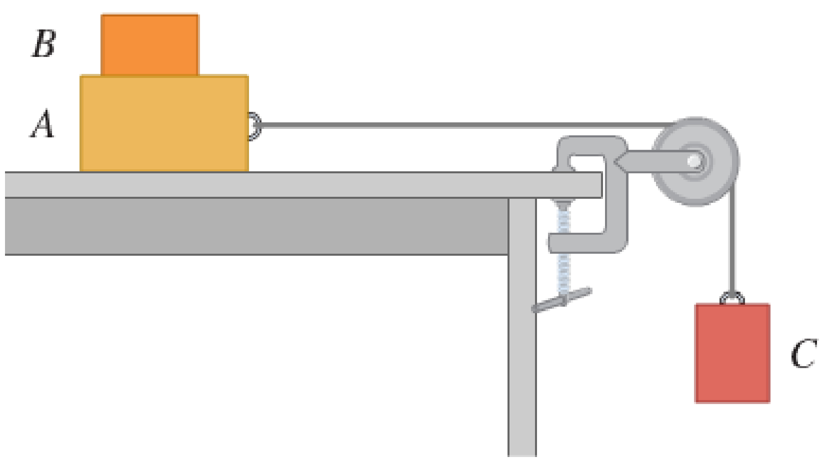


Problem 5.88

- Acceleration in an inertial frame

5.88. 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. 5.72). There is no friction between block *A* and the tabletop, but the coefficient of static friction between block *A* and block *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?

Figure **5.72** Problem 5.88.

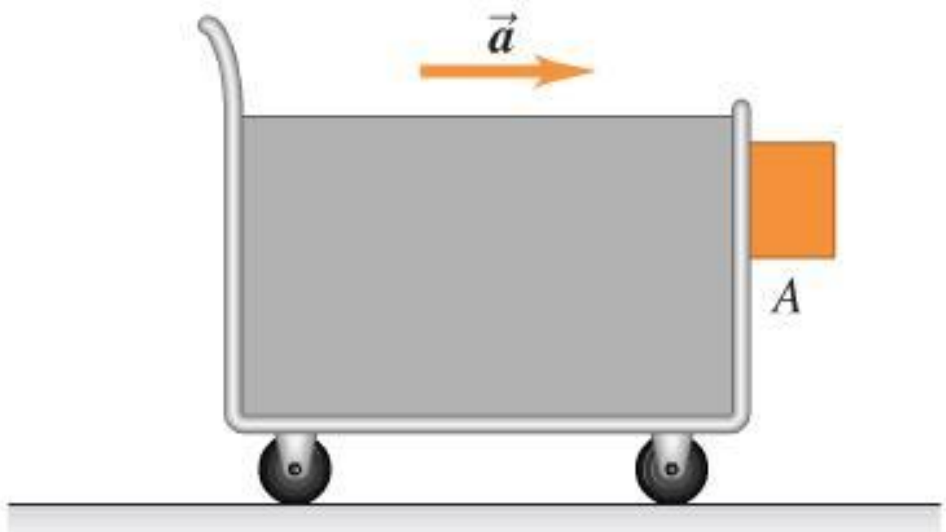


Problem 5.91

- Equilibrium in a non-inertial frame

5.91. A block is placed against the vertical front of a cart as shown in Fig. 5.73. What acceleration must the cart have so that block A does not fall? The coefficient of static friction between the block and the cart is μ_s. How would an observer on the cart describe the behavior of the block?

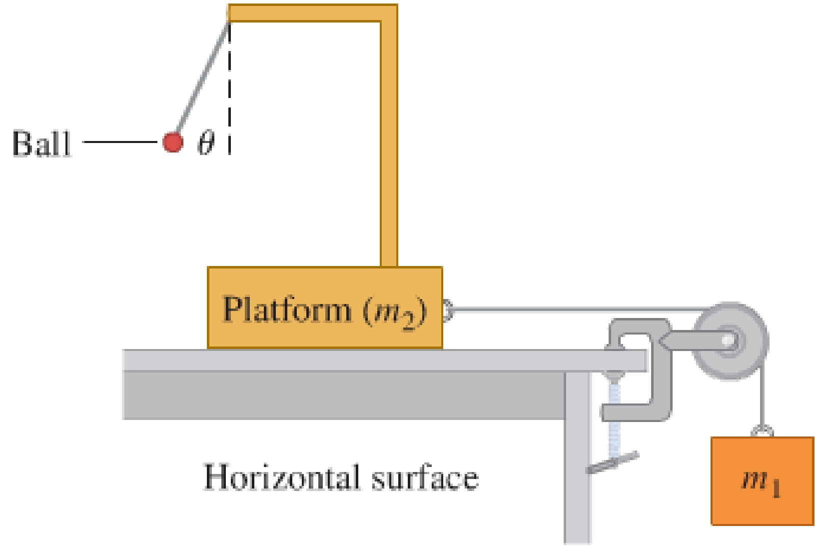
Figure **5.73** Problem 5.91.



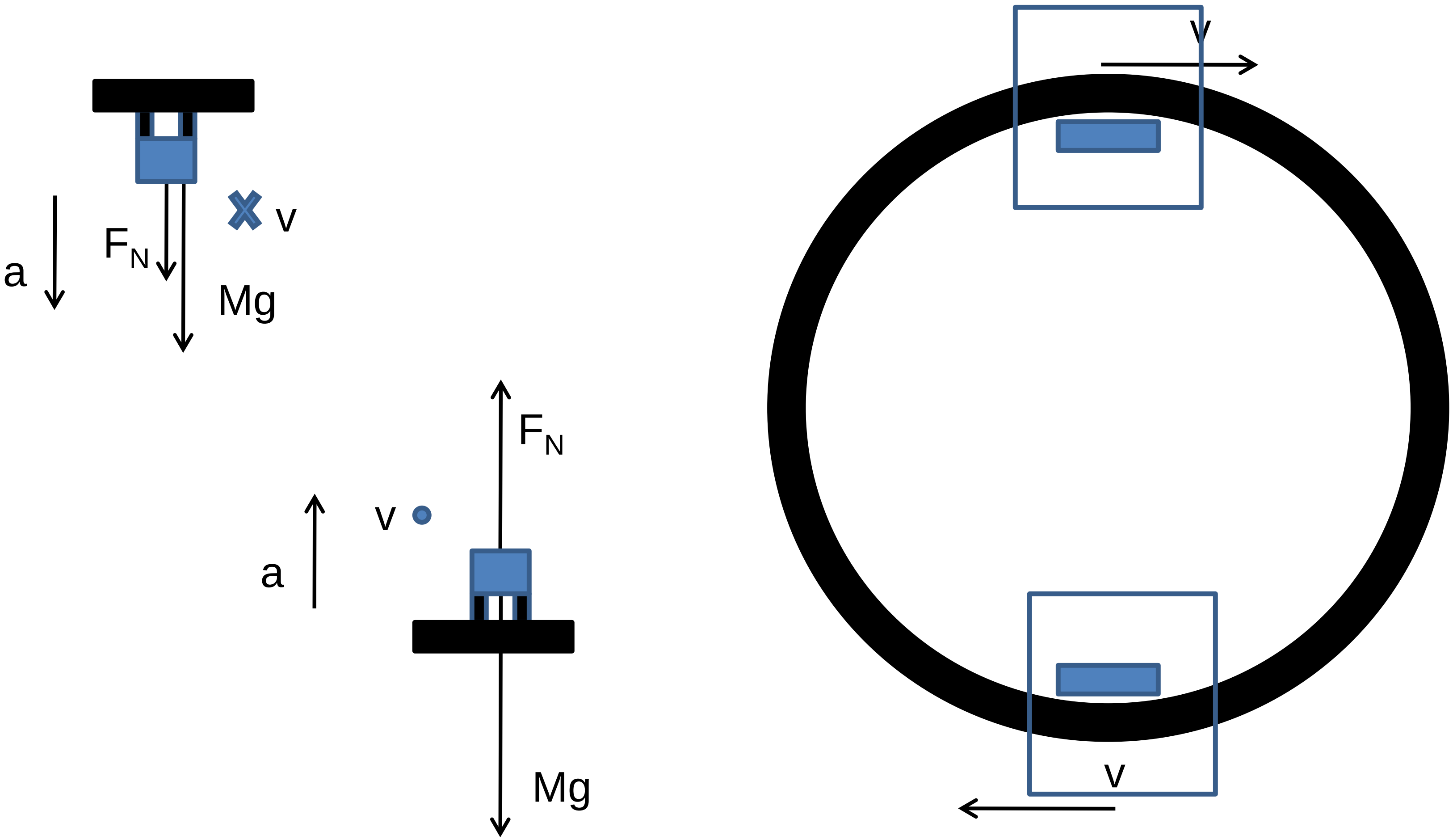
Problem 5.94

5.94. Accelerometer. The system shown in Fig. 5.76 can be used to measure the acceleration of the system. An observer riding on the platform measures the angle θ that the thread supporting the light ball makes with the vertical. There is no friction anywhere. (a) How is θ related to the acceleration of the system? (b) If $m_1 = 250$ kg and $m_2 = 1250$ kg, what is θ? (c) If you can vary m_1 and m_2, what is the largest angle θ you could achieve? Explain how you need to adjust m_1 and m_2 to do this.

Figure **5.76** Problem 5.94.



Uniform Circular Motion Revisited



CPS Question 12-1

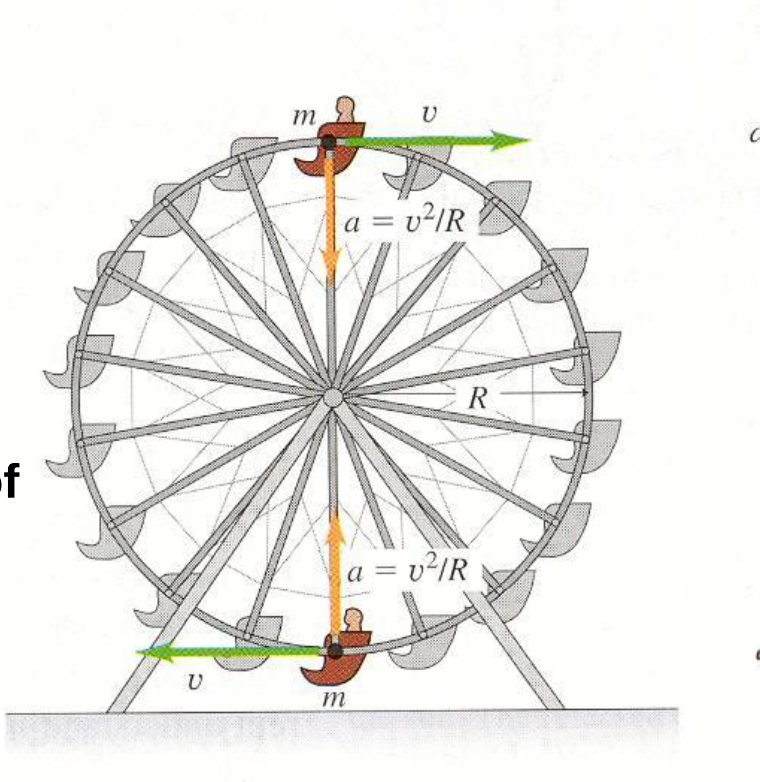
- **For the rider on the Ferris Wheel in uniform circular motion, compare the *force of the wheel on him* at the top and the bottom of the ride.**

A) They are the same, since it is uniform circular motion.

B) It is greater at the top, since there are two accelerations (gravity and circular motion).

C) It is greater on the bottom, since the force of the wheel must also overcome the force of gravity to keep him in circular motion.

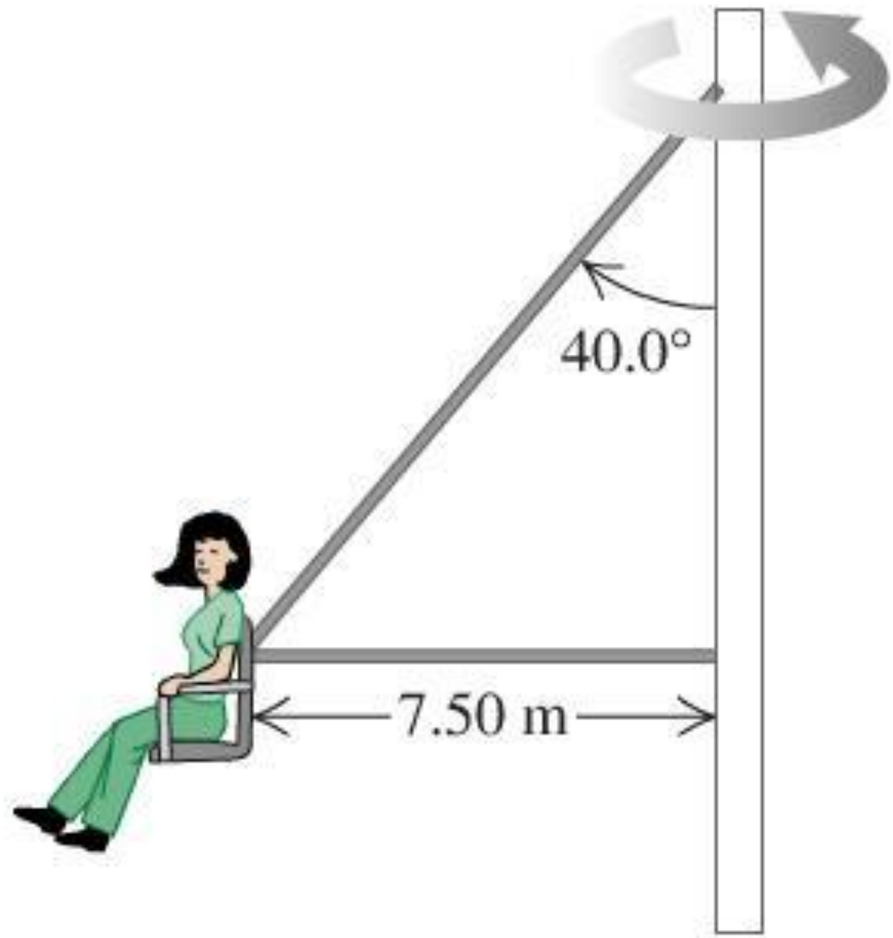
D) Not enough information to solve.



Problem 5.53

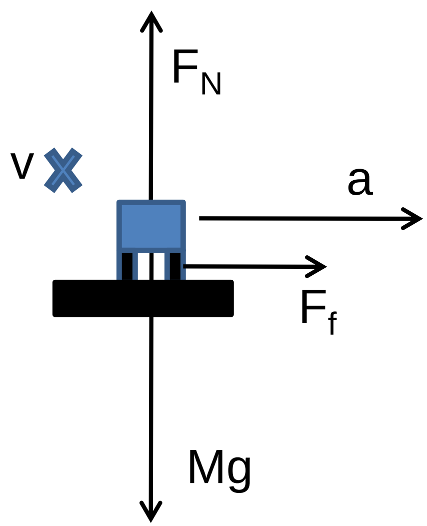
5.53. In another version of the "Giant Swing" (see Exercise 5.52), the seat is connected to two cables as shown in Fig. 5.58, one of which is horizontal. The seat swings in a horizontal circle at a rate of 32.0 rpm (rev/min). If the seat weighs 255 N and a 825-N person is sitting in it, find the tension in each cable.

Figure **5.58** Exercise 5.53.

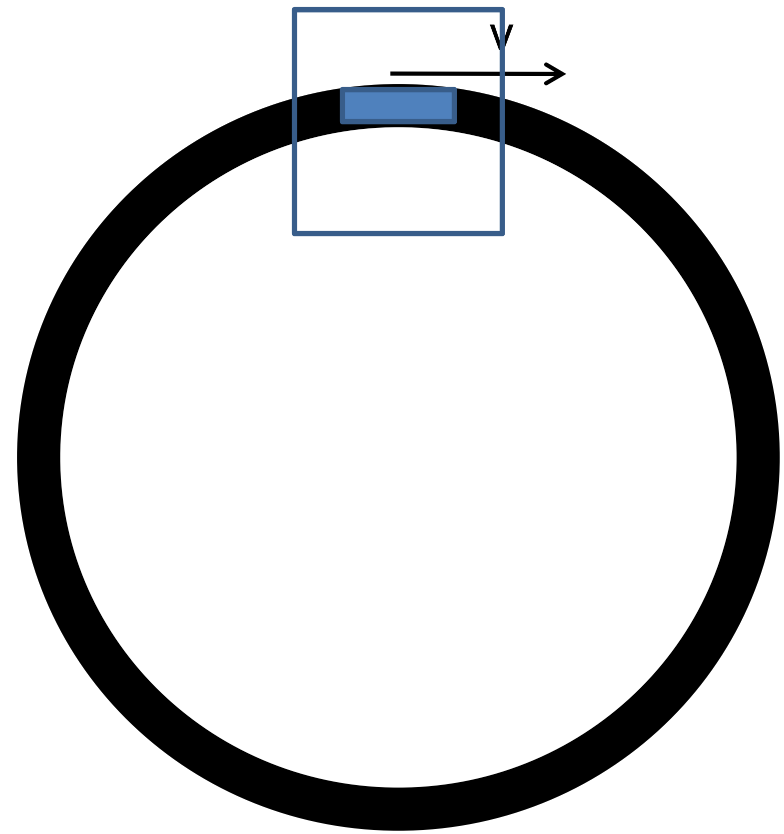


Kinetic or Static Friction?

- In which direction is the friction force?



- Is it kinetic or static?



Problem 5.95

5.95. Banked Curve I. A curve with a 120-m radius on a level road is banked at the correct angle for a speed of 20 m/s. If an automobile rounds this curve at 30 m/s, what is the minimum coefficient of static friction needed between tires and road to prevent skidding?