CHAPTER 4 PRACTICE PASSAGE

As part of a school project, a group of physics students goes on a trip to an amusement park. The students who went on the trip were told to enjoy all the rides, but to be prepared to explain the physics behind two particular ones.

The first ride is a rotating cylinder that spins the riders uniformly in a circle. The passengers initially stand along the outer rim of the cylinder, at a radius $r = 4$ m. When the ride is started up, the cylinder begins to rotate, with its axis of rotation at its center. When a certain speed (v) is achieved, the floor of the ride drops away entirely, leaving the riders suspended against the wall.

In order for the passengers to be suspended, the coefficient of static friction (μ_s) of the wall needs to be large. The larger the coefficient of static friction, the slower the ride needs to spin in order to keep the riders suspended. Normally, $\mu_s = 0.50$. Because of its unique mechanism of action, the riders do not need to be restrained to the wall during the ride (see Figure 1).

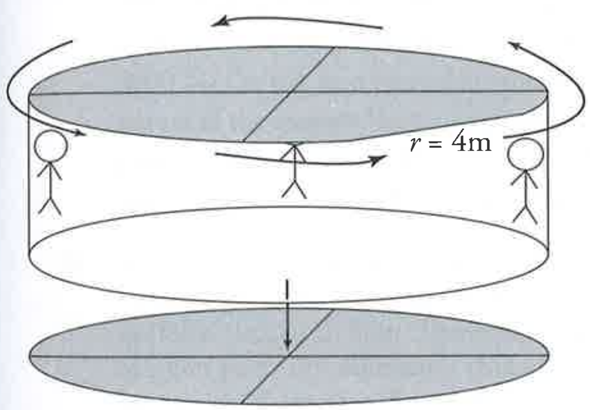

Figure 1 The first ride

The second ride consists of a carriage with mass 300 kg and with maximum occupancy of 300 kg. The carriage is attached to a mechanical arm of length $L = 5$ m that is capable of rotation. The arm is able to provide the torque necessary to swing the riders back and forth on a circular path. Initially, the trips back and forth are very small, but with each trip the swings become larger. Eventually, the riders have enough momentum to swing 360° around, performing a complete circle. In order to partake in this ride, the passengers must be restrained to their seats (see Figure 2).

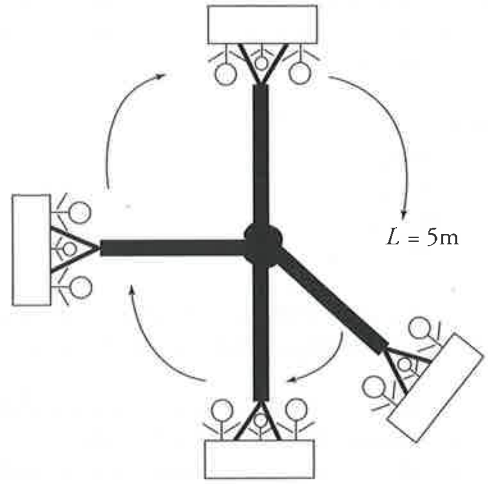

Figure 2 The second ride

1. In the first ride, when the floor drops down and away, the passengers feel pushed up against the wall. Which of the following best explains this phenomenon?

A) The passengers experience a centrifugal force due to the rotation of the ride.
B) The passengers experience a centripetal force due to the rotation of the ride.
C) The passengers experience linear inertia that is opposed by the rotation of the ride.
D) The passages experience rotational inertial that is opposed by the rotation of the ride.

2. In the first ride, what is the tangential speed required to suspend a 50 kg man?

A) 7 m/s
B) 8 m/s
C) 9 m/s
D) 10 m/s

3. In the first ride, when spinning at a speed v, a person with mass m is successfully suspended. If a person with mass $3m$ rides, the ride would have to spin at a speed of:

A) v
B) $3v$
C) $6v$
D) $9v$

4. With a full carriage, the second ride suffers a power outage with the mechanical arm parallel to the ground. How much torque must the mechanical arm provide in order to prevent the passengers from swinging down? (Assume the mechanical arm itself does not require any torque support.)

A) 0 N·m
B) 3×10^4 N·m
C) 18×10^4 N·m
D) 24×10^4 N·m

5. Assume the riders in the second ride are undergoing uniform circular motion. Which of the following is true?

A) The normal force and the centripetal force are at their maximum values at the bottom of the swing.
B) The normal force and the centripetal force are at their maximum values at the top of the swing.
C) The normal force is at maximum value at the bottom of the swing, while the centripetal force value does not change.
D) The normal force is at maximum value at the top of the swing, while the centripetal force is constantly changing.

6. With its carriage full, the second ride goes through the top of its swing. What is the value of the normal force if its speed is 20 m/s?

A) 42 kN
B) 48 kN
C) 54 kN
D) 60 kN

7. In the second ride, a mass of 200 kg is placed on the mechanical arm 3 meters from the center of rotation. In this setup, where is the center of mass relative to the center of rotation? (Assume that the mechanical arm itself has no mass and that the carriage is full.)

A) 3.5 m
B) 4.0 m
C) 4.25 m
D) 4.5 m