Circular Motion

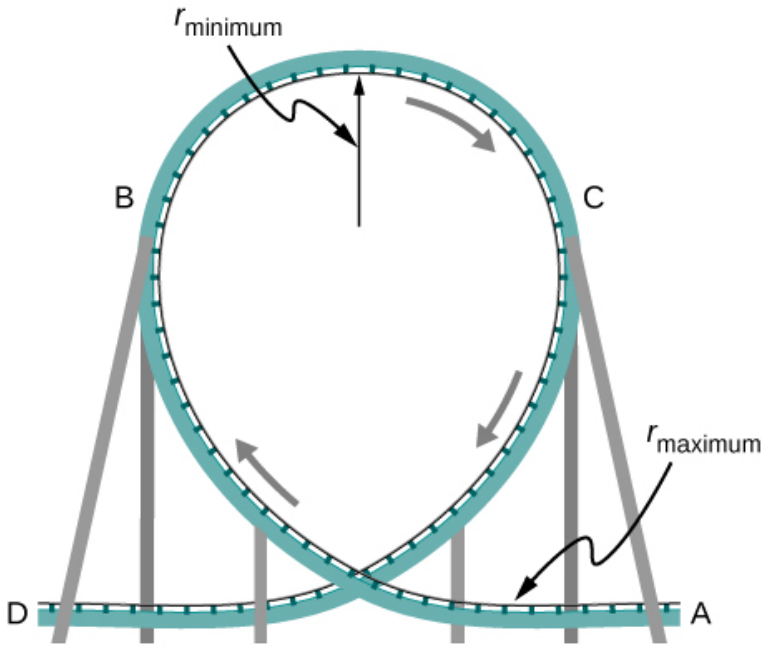
1. A mass moves clockwise on a circular path of radius 2.0 m at a constant speed of 4.0 m/s. Calculate the centripetal acceleration of the mass.

2. A body of mass 1.00 kg is tied to a string and rotates on a horizontal, frictionless table.
   (a) If the length of the string is 40.0 cm and the speed of revolution is 2.00 m/s, determine the tension in the string.
   (b) If the string breaks when the tension exceeds 20.0 N, what is the largest speed the mass can rotate at?
   (c) If the breaking tension of the string is 20.0 N, but you want the mass to rotate at 4.00 m/s, what is the shortest length of string that can be used?

3. In an amusement park, a box is attached to a rod of length 25 m and rotates in a vertical circle. The park claims that the centripetal acceleration felt by the occupants sitting firmly in the box is 4*g*. How many revolutions per minute does the machine make?

4. A 1400 kg car takes a circular flat turn of radius 130 m. The coefficient of static friction between the surface and the tires is 0.65. Calculate the highest speed with which the car can negotiate the turn without skidding.

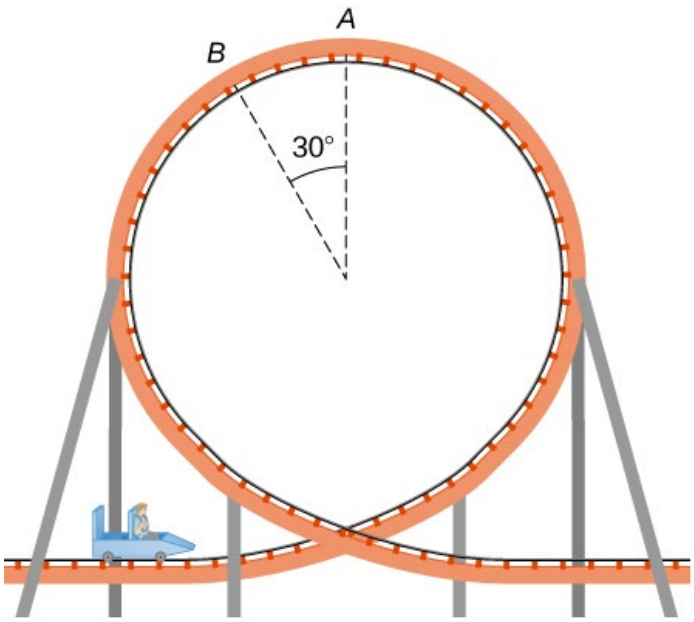
5. Modern roller coasters have vertical loops like the one shown here.



The radius of curvature is smaller at the top than on the sides so that the downward centripetal acceleration at the top will be greater than the acceleration due to gravity, keeping the passengers pressed firmly into their seats. What is the speed of the roller coaster at the top of the loop if the radius of curvature there is 15.0 m and the downward acceleration of the car is 1.50 g? *(Credit: University Physics Volume 1 – OpenStax – CC-BY-4.0)*

6. A loop-the-loop machine has a radius of 18 m. What is the minimum speed at the top of the loop that the cart must travel so that it will safely loop the loop?

7. A child of mass 40.0 kg is in a roller coaster car that travels in a loop of radius 7.00 m.



At point A the speed of the car is 10.0 m/s, and at point B, the speed is 10.5 m/s. Assume the child is not holding on and does not wear a seat belt.
(a) What is the force of the car seat on the child at point A?
(b) What is the force of the car seat on the child at point B?
(c) What minimum speed is required to keep the child in his seat at point A?
(Credit: University Physics Volume 1 – OpenStax – CC-BY-4.0)

8. Calculate the minimum coefficient of friction needed for a car to negotiate an unbanked 50.0 m radius curve at 30.0 m/s. What is unreasonable about the result?
(Credit: College Physics 2e – OpenStax – CC-BY-4.0)

9. Riders in an amusement park ride shaped like a Viking ship hung from a large pivot are rotated back and forth like a rigid pendulum of length 28.0 m. Sometime near the middle of the ride, the ship is momentarily motionless at the top of its circular arc. The ship then swings down under the influence of gravity. The speed at the bottom of the arc is 23.4 m/s.
(a) Find the force exerted by the ride on a 60.0 kg rider and compare it to her weight.
(b) Discuss whether the answer seems reasonable.
(Credit: College Physics 2e – OpenStax – CC-BY-4.0)

10. A mother pushes her child on a swing so that his speed is 9.00 m/s at the lowest point of his path. The swing is suspended 2.00 m above the child's center of mass (radius is 2.00 m)
(a) What is the magnitude of the force the child exerts on the seat if his mass is 18.0 kg?
(b) What is unreasonable about these results?
(Credit: College Physics 2e – OpenStax – CC-BY-4.0)