Vertical Circular Motion

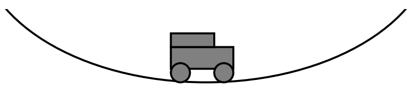
Problems Worksheet

1. A 75.0 kg passenger on a 30.0 m high ferris wheel completes a rotation once every 3.00 minutes.
    a. Calculate the centripetal force acting on the passenger at the peak of the ride.

    b. If the same passenger was on a 30.0 m high roller coaster that performed a vertical loop in 3.00 s, why is it not possible to determine the centripetal force at the top of the loop with the information given?

2. Dan is driving at 80.0 kmh^{-1} through the base of a dip in the road that has a 210 m curvature radius. Dan has a mass of 65.0 kg and the car has a mass of 950 kg.
    a. Calculate the centripetal force Dan experiences.

    b. Draw a free body diagram showing the physical forces acting on Dan.



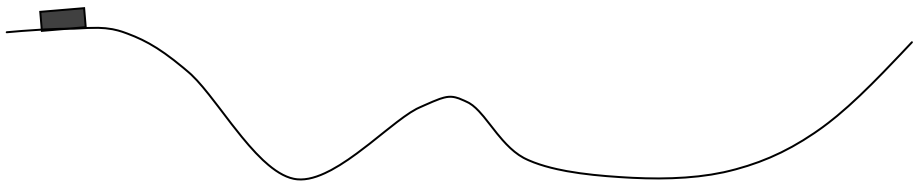
    c. Calculate the reaction force the seat applies to Dan.

3. Dan now reaches the top of a hill while maintaining a speed of 80.0 kmh^{-1}. The peak of the hill has a 56.0 m curvature radius. Dan has a mass of 65.0 kg and the car has a mass of 950 kg.
    a. Draw a vector diagram showing the relationship between the physical forces acting on Dan's car and the centripetal force.
    b. Calculate the reaction force applied to Dan's car by the road.
    c. How much faster than his current speed would Dan need to be driving to feel weightlessness as he drove over the top of the hill?

4. Jackson is trying to impress Amber by showing both his physical skills and aptitude for Physics. He spins a 9.00 L bucket half filled with water around in a vertical loop and explains "the water does not fall out of the bucket because it was still moving up at the top of the loop". Jackson was lucky he did not embarrass himself because he only spun the bucket just fast enough to ensure the water did not fall out.
    a. Estimate the velocity of the water when the bucket is at the peak of the loop.

b. Explain why the water did not fall out of the bucket at the peak of the loop and why Jackson's explanation is wrong.

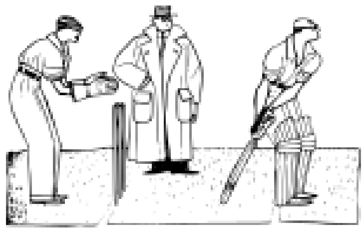
5. During a rollercoaster ride it is common for people to feel much heavier in sections and much lighter in others compared to the sensation when standing on flat ground. The diagram below shows the path of a roller coaster along a vertical plane.

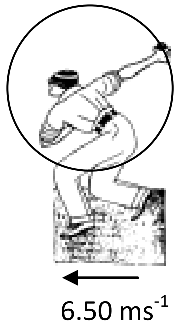


a. Indicate on the diagram the location of the rollercoaster when a passenger will feel heaviest and where they will feel lightest. Clearly label these points as "heaviest" and "lightest".

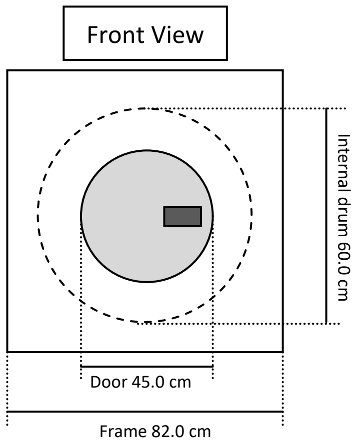
b. Explain, using vector diagrams to assist, why a passenger's apparent weight changes at different stages of the rollercoaster ride.

6. A speed bowler during a cricket match runs towards the crease at 6.50 ms^{-1}. His arm is 85.0 cm long and remains straight as he swings it around in a vertical circle. He releases the ball at the peak of the circle and the batter sees it approaching at 22.0 ms^{-1}. The ball has a mass of 300 g. Calculate the tension in the bowler's arm just prior to releasing the ball.





7. A tumble dryer spins clothes in a drum at a constants speed while drying the clothes. Using the dimensions of the tumble dryer and the manufacturer specifications, determine whether the clothes would stick to the top of the drum as it rotates.



Manufacturer Specifications

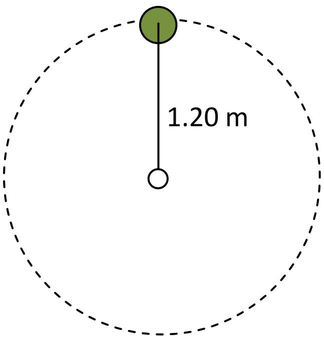
Power	320 W
Revolution speed	50 rpm
Drying Temp	45 ^{0}C
Model Type	Vented

The remaining questions may require theory covered in the Work and Energy in a Gravitational Field topic.

8. A 360 kg rollercoaster is upside down at the peak of a 25.0 m wide vertical loop. The reaction force between the track and the rollercoaster is 1600 N, directed downwards.
   a. Calculate the speed of the rollercoaster when it is at the top of the vertical loop.

   b. Calculate the reaction force supplied by the track when the rollercoaster reaches the bottom of the vertical loop.

9. The 250 g yo-yo in the diagram has a speed of 3.68 ms^{-1} at the position shown as it is swinging from a 1.20 m long string fixed to a pole.
   a. Calculate the tension in the string when the yo-yo is at the top of the loop and the bottom of the loop.



   b. Which part of the swing would the string most likely snap? Justify your answer.

10. A ball is released from rest at the peak of the frictionless track shown in the diagram below. Justify whether the ball will safely be able to follow the track, remaining in contact with the track at all times.