Honors Physics Circular Motion HW, part 1 (Homework)

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1.
It has been suggested that rotating cylinders about 10 mi long and 5.8 mi in diameter be placed in space and used as colonies. What angular speed must such a cylinder have so that the centripetal acceleration at its surface equals Earth's gravity?

2.
(a) What is the tangential acceleration of a bug on the rim of a 10.0 in. diameter disk if the disk moves from rest to an angular speed of 80 revolutions per minute in 3.0 s?
(b) When the disk is at its final speed, what is the tangential velocity of the bug?
(c) One second after the bug starts from rest, what are its tangential acceleration,
radial acceleration, and
total acceleration?

3.
A sample of blood is placed in a centrifuge of radius 14.0 cm. The mass of a red corpuscle is 3.0×10^{-16} kg, and the magnitude of the force required to make it settle out of the plasma is 4.0×10^{-11} N. At how many revolutions per second should the centrifuge be operated?

4.
A 50.0 kg child stands at the rim of a merry-go-round of radius 1.60 m, rotating with an angular speed of 3.00 rad/s.
(a) What is the child's centripetal acceleration?
(b) What is the minimum force between her feet and the floor of the merry-go-round that is required to keep her in the circular path?
(c) What minimum coefficient of static friction is required?
Is the answer you found reasonable? In other words, is she likely to be able to stay on the merry-go-round?

5.
An engineer wishes to design a curved exit ramp for a toll road in such a way that a car will not have to rely on friction to round the curve without skidding. He does so by banking the road in such a way that the necessary centripetal force will be supplied by the component of the normal force toward the center of the circular path.
(a) Show that for a given speed of v and a radius of r, the curve must be banked at the angle θ such that $\tan \theta = v^2/rg$. (Do this on paper. Your instructor may ask you to turn in this proof.)
Proof not shown in the answers.
(b) Find the angle at which the curve should be banked if a typical car rounds it at a 54.0 m radius and a speed of 6.0 m/s.

6.
An air puck of mass 0.30 kg is tied to a string and allowed to revolve in a circle of radius 1.3 m on a frictionless horizontal table. The other end of the string passes through a hole in the center of the table, and a mass of 0.9 kg is tied to it (Fig. P7.26). The suspended mass remains in equilibrium while the puck on the tabletop revolves.

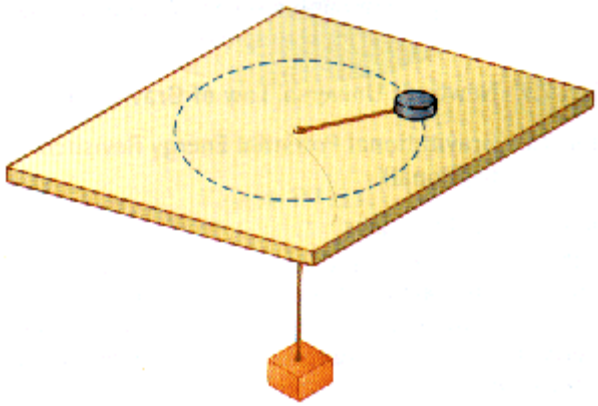

Figure P7.26.

(a) What is the tension in the string?
(b) What is the force causing the centripetal acceleration on the puck?
(c) What is the speed of the puck?

7.
A roller-coaster car has a mass of 497 kg when fully loaded with passengers (Fig. P7.29). (See figure next page.)
(a) If the vehicle has a speed of 22.0 m/s at point *A*, what is the force of the track on the vehicle at this point?
(b) What is the maximum speed the vehicle can have at *B* in order for gravity to hold it on the track?

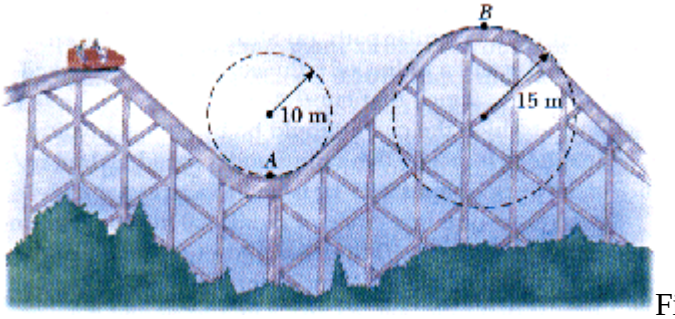

Figure P7.29.

8.
In a popular amusement park ride, a rotating cylinder of radius 2.00 m is set in rotation at an angular speed of 7.00 rad/s, as in Figure P7.53. The floor then drops away, leaving the riders suspended against the wall in a vertical position. What minimum coefficient of friction between a rider's clothing and the wall is needed to keep the rider from slipping? (Hint: Recall that the magnitude of the maximum force of static friction is equal to μn, where n is the normal force - in this case, the force causing the centripetal acceleration.)

Figure P7.53.