Name: ____ **Assignment Due Date: January 13, 2012**

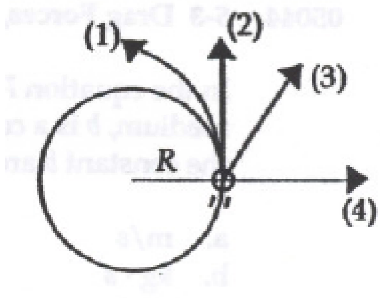
AP Physics: Circular Motion

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. A car going around a curve of radius *R* at a speed *V* experiences a centripetal acceleration a_c. What is its acceleration if it goes around a curve of radius 3*R* at a speed of 2*V*?

a. $(2/3)a_c$
b. $(4/3)a_c$
c. $(2/9)a_c$
d. $(9/2)a_c$
e. $(3/2)a_c$

____ 2. The figure shows a *top view* of a ball on the end of a string traveling counterclockwise in a circular path. The speed of the ball is constant. If the string should break at the instant shown, the path that the ball would follow is



a. 1
b. 2
c. 3
d. 4
e. impossible to tell from the given information.

____ 3. The net force acting on an object is zero. You can therefore definitely conclude that the object is

a. at rest.
b. moving in a straight line at constant speed.
c. moving in a circle at constant speed.
d. undergoing acceleration.
e. either at rest or moving in a straight line at constant speed.

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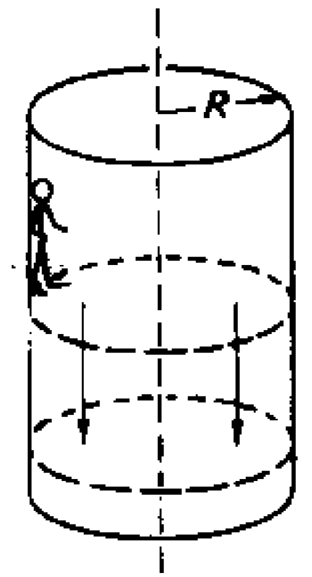
Problem

An amusement park ride consists of a rotating vertical cylinder with rough canvas walls. The floor is initially about halfway up the cylinder wall as shown above. After the rider has entered and the cylinder is rotating sufficiently fast, the floor is dropped down, yet the rider does not slide down. The rider has mass of 50 kilograms, the radius R of the cylinder is 5 meters, the angular velocity of the cylinder when rotating is 2 radians per second (v = 10 m/s), and the coefficient of static friction between the rider and the wall of the cylinder is 0.6.



4. On the diagram below. draw and identify the forces on the rider when the system is rotating and the floor has dropped down.

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5. Calculate the centripetal force on the rider when the cylinder is rotating and state what provides that force.

6. Calculate the upward force that keeps the rider from falling when the floor is dropped down and state what provides that force.

7. At the same rotational speed, would a rider of twice the mass slide down the wall? Explain your answer.

8. A 0.75-kg stone attached to a string is whirled in a horizontal circle of radius 35 cm in a conical pendulum. The string makes an angle of 30° with the vertical. *(a)* Find the speed of the stone. *(b)* Find the tension in the string.

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9. A pilot of mass 50 kg comes out of a vertical dive in a circular arc such that her upward acceleration is 8.5g. *(a)* What is the magnitude of the force exerted by the airplane seat on the pilot at the *bottom* of the arc? *(b)* If the speed of the plane is 345 km/h, what is the radius of the circular arc?

10. A 65-kg airplane pilot pulls out of a dive by following the arc of a circle whose radius is 300 m. At the *bottom* of the circle, where her speed is 180 km/h, *(a)* what are the direction and magnitude of her acceleration? *(b)* What is the net force acting on her at the *bottom* of the circle? *(c)* What is the force exerted on the pilot by the airplane seat?

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11. A man swings his child in a circle of radius 0.75 m, as shown in the photo. If the mass of the child is 25 kg and the child makes one revolution in 1.5 s, what are the magnitude and direction of the force that must be exerted by the man on the child? (Assume the child to be a point particle.)

12. A 750-kg car travels at 90 km/h around a curve with a radius of 160-m. What should the banking angle of the curve be so that the only force between the pavement and tires of the car is the normal reaction force?

AP Physics: Circular Motion

Answer Section

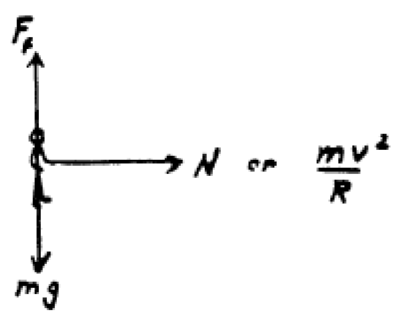
MULTIPLE CHOICE

1. ANS: B REF: Tipler 4th ed Mult Choice Question Bank p.84 #33
2. ANS: B REF: Tipler 4th ed Mult Choice Question Bank p.85 #39
3. ANS: E REF: Tipler 4th ed Mult Choice Question Bank p.86 #42

PROBLEM

4. ANS:

4 points



1 point for each of the three correctly identified forces	3 points
For no extraneous horizontal forces	1 point

REF: AP Physics Final 1984 Free Resp (Mech) #1a

5. ANS:

5 points

$F = \frac{mv^2}{R}$ (1 point) | or $F = mR\omega^2$ — 2 points

$v = R\omega$ (1 point)

$F = 50 \cdot 5 \cdot (2)^2 = 1000$ N — 2 points

(1 point for magnitude, 1 point for units)

The centripetal force is provided by the normal force. — 1 point

REF: AP Physics Final 1984 Free Resp (Mech) #1b

6. ANS:

4 points

$\Sigma F_y = 0$, therefore $F_f = mg$ — 2 points

$F_f = (50)(9.8) = 490$ N — 1 point

The upward f_rce is provided by friction. — 1 point

REF: AP Physics Final 1984 Free Resp (Mech) #1c

7. ANS:

2 points

No — 1 point

For correct justification involving recalculation with m replaced by 2m or by arguing that m cancels in appropriate equations, e.g., $\mu mR\omega^2 \geq mg$ — 1 point

REF: AP Physics Final 1984 Free Resp (Mech) #1d

8. ANS:

This problem is identical to Problem 5-48; since the angle θ is with respect to the vertical, the expressions for v and T must be changed accordingly.

(*a*), (*b*) Write v and T in terms of θ and r — $v = \sqrt{rg \tan \theta}$; $T = mg/\cos \theta$

Evaluate v and T — $v = 1.41$ m/s; $T = 8.5$ N

REF: Tipler4thed.p.142#49

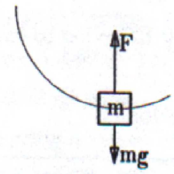
9. ANS:

(*a*) 1. Draw the free-body diagram

2. Apply $\Sigma F = ma$ — $F - mg = ma$

3. Solve for and evaluate F — $F = 9.5mg = 4660$ N

(*b*) $r = v^2/a_c$; evaluate for $a_c = 8.5g$, $v = 95.8$ m/s — $r = 110$ m



REF: Tipler4thed.p.143#51

10. ANS:

(*a*) 1. See Problem 5-51 for the free-body diagram.

2. $a = a_c = v^2/r$ — $a = (50^2/300)$ m/s^2 = 8.33 m/s^2, directed up

(*b*) $F_{net} = ma$ — $F_{net} = (65 \times 8.33)$ N = 542 N, directed up

(*c*) $F = mg + F_{net}$ — $F = (542 + 65 \times 9.81)$ N = 1179 N, directed up

REF: Tipler4thed.p.143#52

11. ANS:

1. See Problem 5-49. In this problem T stands for the period.

2. $\tan\theta = v^2/rg = r\omega^2/g = 4\pi^2 r/gT^2$ (see Problem 5-49) — $\tan\theta = (4\pi^2 \times 0.75)/(9.81 \times 1.5^2) = 1.34$; $\theta = 53.3°$

3. $F = mg/\cos\theta$ — $F = (25 \times 9.81/\cos 53.3°) = 410$ N

REF: Tipler4thed.p.143#57

12. ANS:

1. See Example 5-12. — $\theta = \tan^{-1}(v^2/rg) = 21.7°$.

REF: Tipler4thed.p.145#72