AP PHYSICS C: ROTATIONAL MOTION

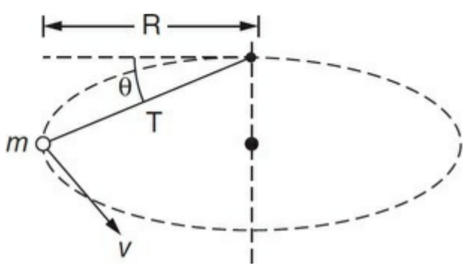
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and place the letter of your choice in the corresponding box on the student answer sheet.

Note: To simplify calculations, you may use $g = 10\,\mathrm{m/s^2}$ in all problems.

1. A girl stands on a rotating merry-go-round without holding on to a rail. The force that keeps her moving in a circle is the

(A) frictional force on the girl directed away from the center of the merry-go-round
(B) frictional force on the girl directed toward the center of the merry-go-round
(C) normal force on the girl directed away from the center of the merry-go-round
(D) normal force on the girl directed toward the center of the merry-go-round
(E) weight of the girl

2. A 0.5 kg ball on the end of a 0.5 m long string is swung in a horizontal circle. What would the speed of the ball have to be for the tension in the string to be 9.0 N?



(A) 1 m/s
(B) 3 m/s
(C) 6 m/s
(D) 9 m/s
(E) 12 m/s

3. A ball of mass m is swung in a vertical circle of radius R. The speed of the ball at the bottom of the circle is v. The tension in the string at the bottom of the circle is

(A) mg
(B) $mg + \dfrac{mv^2}{R}$
(C) $mg - \dfrac{mv^2}{R}$
(D) $\dfrac{mv^2}{R}$
(E) zero

4. A car of mass m drives on a flat circular track of radius R. To maintain a constant speed v on the track, the coefficient of friction μ between the tires and the road must be

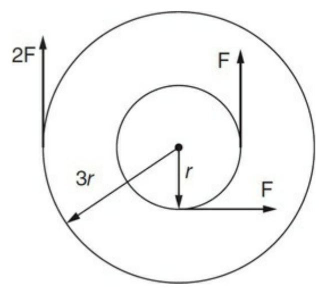
(A) mg
(B) $mg + \dfrac{mv^2}{R}$
(C) $mg - \dfrac{mv^2}{R}$
(D) $\dfrac{v^2}{gR}$
(E) $\sqrt{\dfrac{v^2}{gR}}$

5. A ball on the end of a string is swung in a circle of radius 2 m according to the equation $\theta = 4t^2 + 3t$, where θ is in radians and t is in seconds. The angular acceleration of the ball is

(A) $6\,\mathrm{rad/s^2}$
(B) $4t^2 + 3t\ \mathrm{rad/s^2}$
(C) $8t + 3\ \mathrm{rad/s^2}$
(D) $\dfrac{3}{4}t^3 + 3t^2\ \mathrm{rad/s^2}$
(E) $8\,\mathrm{rad/s^2}$

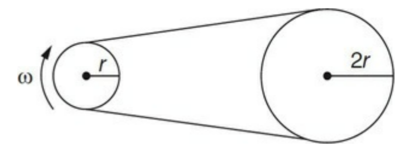
6. The linear speed v of the ball (in the previous question) at $t = 3$ s is
   (A) 27 m/s
   (B) 54 m/s
   (C) 108 m/s
   (D) 135 m/s
   (E) 210 m/s

7. Two wheels are attached to each other and fixed so that they can only turn together. The smaller wheel has a radius of r and the larger wheel has a radius of $3r$. The two wheels can rotate together on a frictionless axle. Three forces act tangentially on the edge of the wheels as shown. The magnitude of the net torque acting on the system of wheels is



   (A) Fr
   (B) $2Fr$
   (C) $3Fr$
   (D) $4Fr$
   (E) $6Fr$

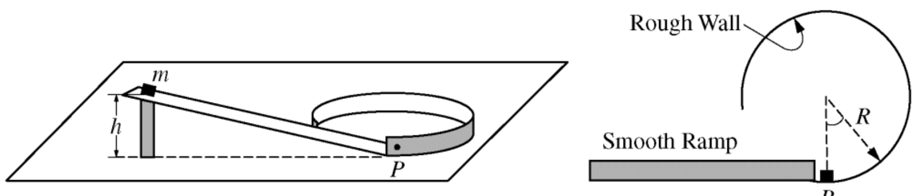
8. A belt is wrapped around two wheels as shown. The smaller wheel has a radius r, and the larger wheel has a radius $2r$. When the wheels turn, the belt does not slip on the wheels, and gives the smaller wheel an angular speed ω. The angular speed of the larger wheel is



   (A) ω
   (B) 2ω
   (C) $\frac{1}{2}\omega$
   (D) $\frac{1}{4}\omega$
   (E) 4ω

AP PHYSICS 1 & C: CIRCULAR MOTION AND SIMPLE HARMONIC MOTION
SECTION II
6 Questions

Directions: Answer all questions. The parts within a question may not have equal weight. All final numerical answers should include appropriate units. Credit depends on the quality of your solutions and explanations, so you should show your work. Credit also depends on demonstrating that you know which physical principles would be appropriate to apply in a particular situation. Therefore, you should clearly indicate which part of a question your work is for. 10



Side View Top View

1. A small block of mass m starts from rest at the top of a frictionless ramp, which is at a height h above a horizontal tabletop, as shown in the side view above. The block slides down the smooth ramp and reaches point P with a speed v_0. After the block reaches point P at the bottom of the ramp, it slides on the tabletop guided by a circular vertical wall with radius R, as shown in the top view. The tabletop has negligible friction, and the coefficient of kinetic friction between the block and the circular wall is μ.

   (a) Derive an expression for the height of the ramp h. Express your answer in terms of u_0, m, and fundamental constants, as appropriate.

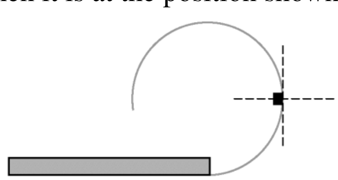
   A short time after passing point P, the block is in contact with the wall and moves with a speed of u.

   (b) i. Is the vertical component of the net force on the block upward, downward, or zero?

   ____ Upward ____ Downward ____ Zero

   Justify your answer.

   ii. On the figure below, draw an arrow starting on the block to indicate the direction of the horizontal component of the net force on the moving block when it is at the position shown.



Top View

Express your answers to the following in terms of v_0, v, m, R, m, and fundamental constants, as appropriate.

(c) Determine an expression for the magnitude of the normal force N exerted on the block by the circular wall as a function of v.

(d) Derive an expression for the magnitude of the tangential acceleration of the block at the instant the block has attained a speed of v.

(e) Derive an expression for $v(t)$, the speed of the block as a function of time t after passing point P on the track.