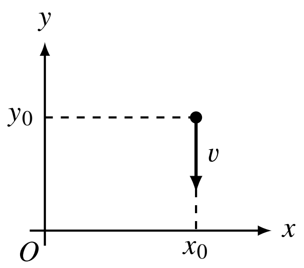
Student #: ___________________________ Student Name: _________________________________

AP PHYSICS C CLASS 8: ROTATIONAL MOTION, PART 2

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.

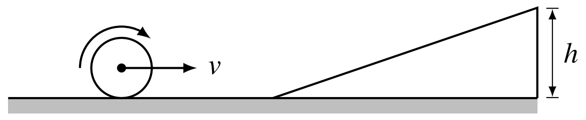
Note: To simplify calculations, you may use $g = 10\,\mathrm{m/s^2}$ in all problems.

1. A particle of mass m moves with a constant speed v at a distance x_0 parallel to the y-axis as shown. When the particle is in the position shown below, the magnitude of its angular momentum relative to the origin is



(A) mvx_0
(B) mvy_0
(C) $mv\sqrt{x_0^2 + y_0^2}$
(D) $\dfrac{mv}{\sqrt{x_0^2 + y_0^2}}$
(E) zero

2. A hoop of radius R and mass m has a rotational inertia of mR^2. The hoop rolls without slipping along a horizontal floor with a constant speed v and then rolls up a long incline. The hoop can roll up the incline to a maximum vertical height of



(A) $\dfrac{v^2}{g}$
(B) $\dfrac{2v^2}{g}$
(C) $\dfrac{v^2}{2g}$
(D) $\dfrac{4v^2}{g}$
(E) $\dfrac{v^2}{4g}$

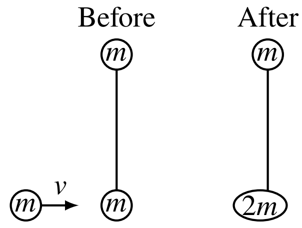
3. A disk is mounted on a fixed axle. The rotational inertia of the disk is I. The angular velocity of the disk is decreased from ω_i to ω_f during a time Δt due to friction in the axle. The magnitude of the average net torque acting on the wheel is

(A) $\dfrac{\omega_f - \omega_i}{\Delta t}$
(B) $\dfrac{(\omega_f - \omega_i)^2}{\Delta t}$
(C) $\dfrac{I(\omega_f - \omega_i)}{\Delta t}$
(D) $\dfrac{I(\omega_f - \omega_i)^2}{\Delta t}$
(E) $\dfrac{I(\omega_f - \omega_i)}{\Delta t^2}$

4. The average power developed by the friction in the axle of the disk from the previous question to bring it to a complete stop is

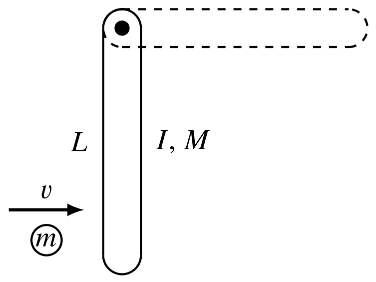
(A) $\dfrac{\omega_i}{\Delta t}$
(B) $\dfrac{\omega_i^2}{\Delta t}$
(C) $\dfrac{I\omega_i}{2\Delta t}$
(D) $\dfrac{I\omega_i^2}{\Delta t}$
(E) $\dfrac{I\omega_i}{\Delta t^2}$

5. Astronauts are conducting an experiment in a negligible gravity environment. Two spheres of mass m are attached to either end of a light rod. As the rod and spheres float motionless in space, an astronaut launches a piece of sticky clay, also of mass m, toward one of the spheres so that the clay strikes and sticks to the sphere perpendicular to the rod. Which of the following statements is true of the motion of the rod, clay, and spheres after the collision?



(A) Linear momentum is not conserved, but angular momentum is conserved.
(B) Angular momentum is not conserved, but linear momentum is conserved.
(C) Kinetic energy is conserved, but angular momentum is not conserved.
(D) Kinetic energy is conserved, but linear momentum is not conserved.
(E) Both linear momentum and angular momentum are conserved, but kinetic energy is not conserved.

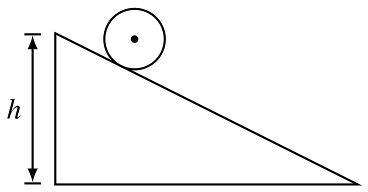
6. A rod of mass M, length L, and rotational inertia I hangs at rest from a frictionless axle as shown. A ball of mass m with a speed v strikes therod perpendicularly at the end of the rod. As a result of the collision, the ball stops. The angular speed of the rod immediately after the collision is



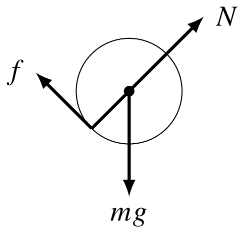
(A) vL
(B) $\dfrac{v}{L}$
(C) $\dfrac{mv}{I}$
(D) $\dfrac{mvL}{I}$
(E) $\dfrac{mv}{IL}$

Questions 7–8

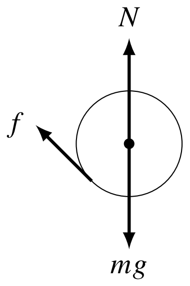
A hollow sphere of mass m and radius R begins from rest at a height h and rolls down a rough inclined plane. The rotational inertia of the hollow sphere is $\frac{2}{3}mR^2$.



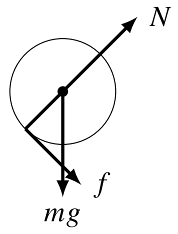
7. Which of the following diagrams best represents the forces acting on the sphere as it rolls down the plane?



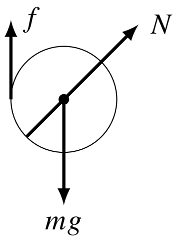
(A)



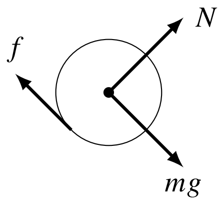
(B)



(C)



(D)



(E)

8. The speed of the sphere when it reaches the bottom of the plane is

(A) $\frac{8gh}{5}$

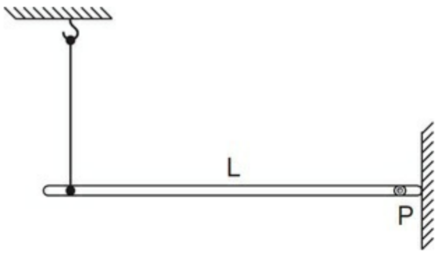
(B) $\frac{6gh}{5}$

(C) $\frac{5gh}{6}$

(D) $\frac{7gh}{10}$

(E) $\frac{gh}{2}$

9. One end of a stick of length L, rotational inertia I, and mass m is pivoted on an axle with negligible friction at point P. The other end is tied to a string and held in a horizontal position. When the string is cut, the stick rotates counterclockwise. The angular speed ω of the stick when it reaches the bottom of its swing is



(A) $\frac{mgL}{I}$

(B) $\sqrt{\frac{mgL}{I}}$

(C) $\sqrt{\frac{2mgL}{I}}$

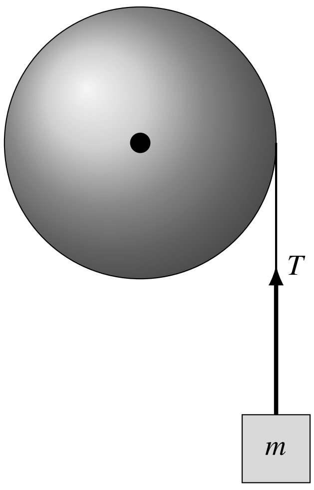
(D) $\sqrt{\frac{mgL}{2I}}$

(E) $\sqrt{\frac{4mgL}{I}}$

AP PHYSICS C CLASS 8: ROTATIONAL MOTION, PART 2
SECTION II
4 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.

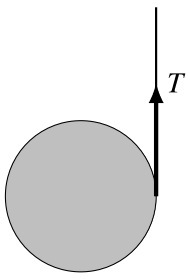
1. A uniform sphere of mass M and radius R is free to rotate, without friction, about a horizontal axis through its center. A string is wrapped around the sphere and is attached to a body of mass m as shown in the figure below. Find



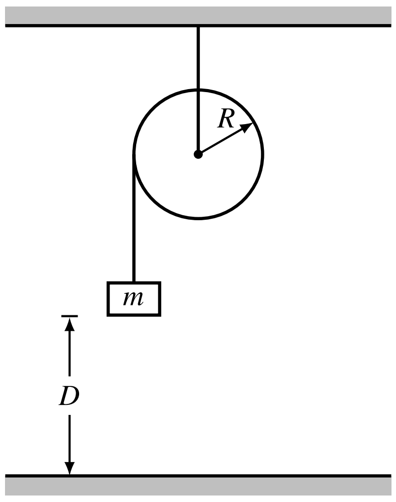
   (a) the acceleration of the body, and

   (b) the tension in the string.

2. A uniform cylinder of mass M and radius R has a string wrapped around it. The string is held fixed, and the cylinder falls vertically as shown in the figure below. Find



   (a) the acceleration of the body, and
   (b) the tension in the string.



3. A solid disk of unknown mass and known radius R is used as a pulley in a lab experiment, as shown above. A small block of mass m is attached to a string, the other end of which is attached to the pulley and wrapped around it several times. The block of mass m is released from rest and takes a time t to fall the distance D to the floor.

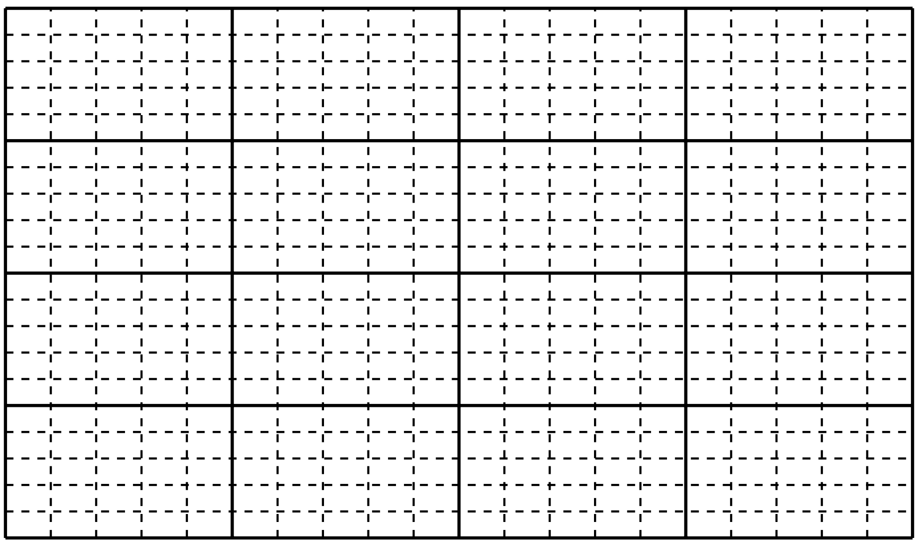
(a) Calculate the linear acceleration a of the falling block in terms of the given quantities.

(b) The time t is measured for various heights D and the data are recorded in the following table.

D (m)	t (s)
0.5	0.68
1	1.02
1.5	1.19
2	1.38

i. What quantities should be graphed in order to best determine the acceleration of the block? Explain your reasoning.

ii. On the grid below, plot the quantities determined in (b)i, label the axes, and draw the best-fit line to the data.

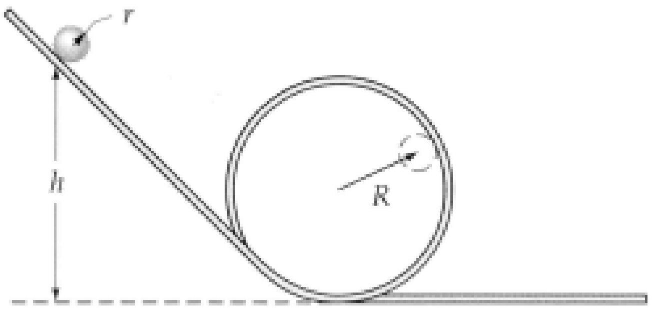


iii. Use your graph to calculate the magnitude of the acceleration.

(c) Calculate the rotational inertia of the pulley in terms of m, R, a, and fundamental constants.

(d) The value of acceleration found in (b)iii, along with numerical values for the given quantities and your answer to (c), can be used to determine the rotational inertia of the pulley. The pulley is removed from its support and its rotational inertia is found to be greater than this value. Give one explanation for this discrepancy.

4. A uniform ball of radius r rolls without slipping along the loop-the-loop track in the figure below. The ball starts at rest at a height of h above the bottom of the loop.



(a) If it is not to leave the track at the top of the loop, what is the least value h can have (in terms of radius R of the loop)?

(b) What would h have to be if, instead of rolling, the ball slides without friction?