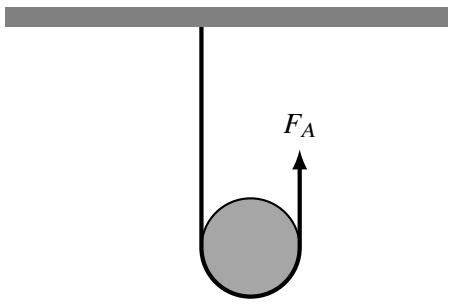
Student #: _____ Student Name: _____

AP PHYSICS C CLASS 9: ROTATIONAL MOTION, PART 3
SECTION II
2 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 disk of mass $M = 2.0\,\text{kg}$ and radius $R = 0.10\,\text{m}$ is supported by a rope of negligible mass, as shown above. The rope is attached to the ceiling at one end and passes under the disk. The other end of the rope is pulled upward with a force F_A. The rotational inertia of the disk around its center is $MR^2/2$.

   (a) Calculate the magnitude of the force F_A necessary to hold the disk at rest.

   At time $t = 0$, the force F_A is increased to 12 N, causing the disk to accelerate upward. The rope does not slip on the disk as the disk rotates.

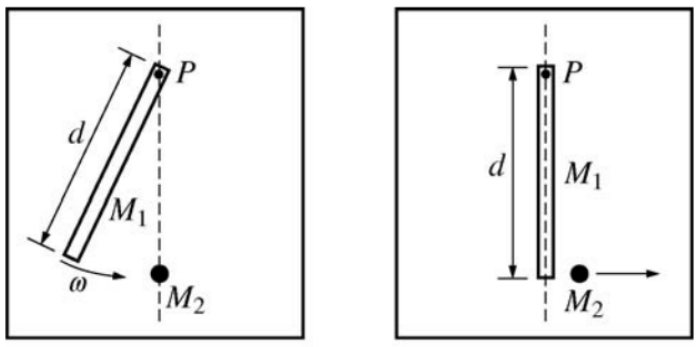
   (b) Calculate the linear acceleration of the disk.

   (c) Calculate the angular speed of the disk at $t = 3.0\,\text{s}$.

   (d) Calculate the increase in total mechanical energy of the disk from $t = 0$ to $t = 3.0\,\text{s}$.

   (e) The disk is replaced by a hoop of the same mass and radius. Indicate whether the linear acceleration of the hoop is greater than, less than, or the same as the linear acceleration of the disk. Justify your answer.

   ____ Greater than ____ Less than ____ The same as



Before Collision After Collision

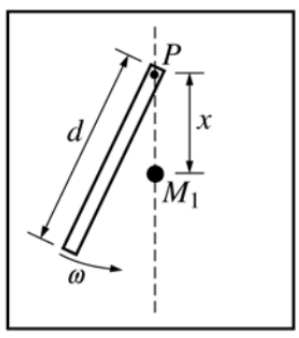
TOP VIEWS

2. A system consists of a ball of mass M_2 and a uniform rod of mass M_1 and length d. The rod is attached to a horizontal frictionless table by a pivot at point P and initially rotates at an angular speed ω , as shown above left. The rotational inertia of the rod about point P is $\frac{1}{3}M_1d^2$. The rod strikes the ball, which is initially at rest. As a result of this collision, the rod is stopped and the ball moves in the direction shown above right. Express all answers in terms of M_1, M_2, ω, d, and fundamental constants.

   (a) Derive an expression for the angular momentum of the rod about point P before the collision.

   (b) Derive an expression for the speed v of the ball after the collision.

   (c) Assuming that this collision is elastic, calculate the numerical value of the ratio M_1/M_2.



Before Collision

   (d) A new ball with the same mass M_1 as the rod is now placed a distance x from the pivot, as shown above. Again assuming the collision is elastic, for what value of x will the rod stop moving after hitting the ball?