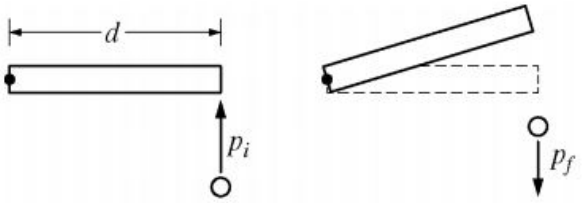
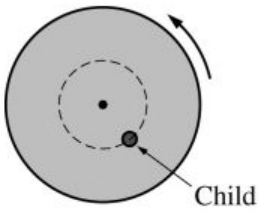


Top View

1. A thin rod of length d on a frictionless surface is pivoted about one end, as shown above, and can rotate freely. The rod is at rest when it is struck by a sphere with linear momentum of magnitude p_i perpendicular to the rod. The sphere rebounds along its original line of motion with momentum of magnitude p_f. What is the magnitude of the angular momentum of the rod immediately after the collision?

(A) $p_f - p_i$
(B) $p_f + p_i$
(C) $(p_f - p_i)d$
(D) $(p_f + p_i)d$



Top View

The diagram above shows a top view of a child of mass M on a circular platform of mass $5M$ that is rotating counterclockwise. Assume the platform rotates without friction. Which of the following describes an action by the child that will result in an increase in the total angular momentum of the child-platform system?

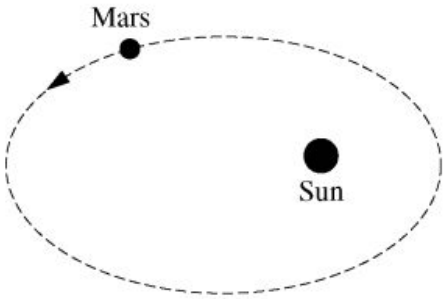
(A) The child moves toward the center of the platform.
(B) The child moves away from the center of the platform.
(C) The child moves along a circle concentric with the platform (dashed line shown) opposite the direction of the platform's rotation.
(D) None of the actions described will change the total angular momentum of the child-platform system.

. A satellite that is a spinning cylinder has initial rotational inertia I_0 and angular velocity ω_0. Solar panels unfold from the satellite and are extended outward. The satellite then has rotational inertia $I_f = aI_0$ and angular velocity $\omega_f = b\omega_0$, where a and b are constants. Which of the following is true about the constants a and b ?

(A) $a = 1$ and $b = 1$
(B) $a > 1$ and $b < 1$
(C) $a > 1$ and $b = 1$
(D) $a < 1$ and $b < 1$

A disk of known radius and rotational inertia can rotate without friction in a horizontal plane around its fixed central axis. The disk has a cord of negligible mass wrapped around its edge. The disk is initially at rest, and the cord can be pulled to make the disk rotate. Which of the following procedures would best determine the relationship between applied torque and the resulting change in angular momentum of the disk?

(A) Pulling on the cord, exerting a force of 15 N for 2 s and then 25 N for 3 s, and measuring the final angular velocity of the disk
(B) For five different time intervals, pulling on the cord, exerting a force of 15 N, and then measuring the angle through which the disk rotates in each case
(C) For five different time intervals, pulling on the cord, exerting a force of 15 N, and then measuring the final angular velocity of the disk
(D) For five forces of different magnitude, pulling on the cord for 5 s, and then measuring the final angular velocity of the disk



Note: Figure not drawn to scale.

Mars moves in an elliptical orbit around the Sun, and the mass of Mars is much less than the mass of the Sun. At the instant shown above, Mars is getting farther away from the Sun. How does this affect the potential energy of the Mars-Sun system and the magnitude of Mars's angular momentum with respect to the Sun?

	System Potential Energy	Mars's Angular Momentum
(A)	**Increases**	Increases
(B)	Increases	Remains the same
(C)	Decreases	Decreases
(D)	Decreases	Remains the same

Side View

A ball attached to a light string swings in a counterclockwise vertical circle, as shown above. Which of the following arrows represent one of the forces exerted on the ball at the moment it passes through point P ? Select two answers.

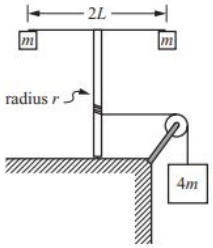
(A)

(B)

(C)

(D)

Free-Response Question



A light string that is attached to a large block of mass $4m$ passes over a pulley with negligible rotational inertia and is wrapped around a vertical pole of radius r, as shown in Experiment A above. The system is released from rest, and as the block descends the string unwinds and the vertical pole with its attached apparatus rotates. The apparatus consists of a horizontal rod of length $2L$, with a small block of mass m attached at each end. The rotational inertia of the apparatus is assumed to be $2mL^2$.

(a) If the downward acceleration of the large block is measured to be a, determine the tension T in the string, in terms of the acceleration of the falling block.
(b) Determine the torque exerted on the rotating pole by the string, in terms of the mass of the blocks and the acceleration.
(c) When the large block has descended a distance D, how does the instantaneous rotational kinetic energy of the apparatus compare with the value $4mgD$? Check the appropriate space below and justify your answer.

_____Greater than $4mgD$ _____Equal to $4mgD$ _____Less than $4mgD$