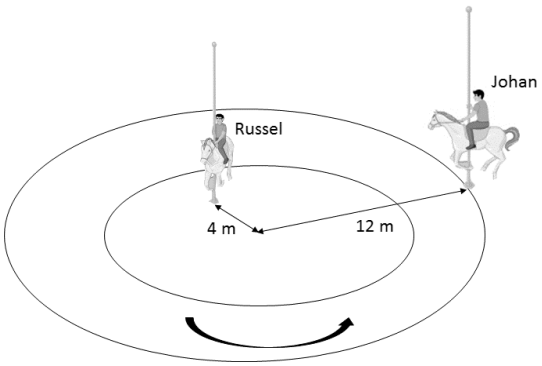
AP Physics 1 Name: _____

Unit 5&6 Test: Rotation Multiple Choice

Part 1: Multiple Choice - Choose the answers that best answers the questions below. If an exact answer is not present, chose the closest available answer. (4 pts each)

(1-2) Russel and Johan ride the Merry-Go-Round as shown. Russel rides at a distance from 3 m from the center of the Merry-Go-Round and Johan rides at 9 m from the center. The Merry-Go-Round goes around (as the name implies) in a counter-clockwise circle. In a 10 s span of time, Johan travels around a total linear distance of 120 m.



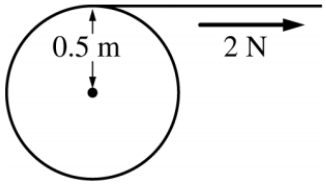
1. What was Johan's average *angular* velocity during the 10 s?

A) 12.0 rad/s B) 1.0 rad/s

C) 1.9 rad/s D) 3.0 rad/s

2. What Russel's average linear velocity during the 10 s?

A) 6.3 m//s B) 1.0 m/s C) 4.0 m/s D) 3.0 rad/s



3. A disk with radius of 0.5 m is free to rotate around its center without friction. A string wrapped around the disk is pulled, as shown above, exerting a 2 N force tangent to the edge of the disk for 1 s. If the disk starts from rest, what is its angular speed after 1 s?

A) 0 rads/s B) 1 rads/s C) 2 rads/s D) 4 rads/s

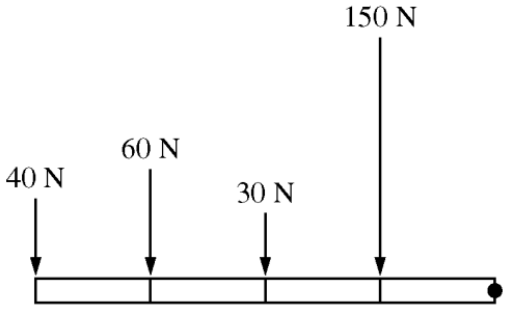
4. A wheel is mounted on a fixed, frictionless axle. The angular speed of the wheel is increased from 0 to ω in a time interval T. How many revolutions does the wheel make in the time interval?

A) $\frac{\omega T}{2}$ B) $\frac{\omega T}{2\pi}$ C) $\pi\omega t$ D) $\frac{\omega T}{4\pi}$

5. A 2.0-kg solid cylinder of radius 0.5 m rotates at a rate of 40 rad/s about its cylindrical axis. What *power* is required to bring the cylinder to rest in 10 s?

A) 20 W B) 40 W C) 160 W D) 200 W

6. The figure shown on the right represents a stick of uniform density that is attached to a pivot at the right end and has equally spaced marks along its length. Any one of the four forces shown can be exerted on the stick as indicated. Which force will create the largest rate of change in the stick's angular momentum?

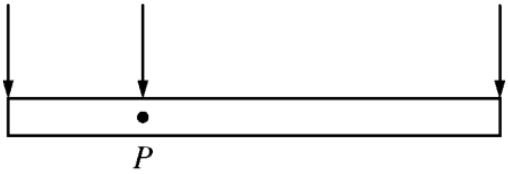


A) The 30 N force

B) The 40 N force

C) The 60 N force

D) The 150 N force

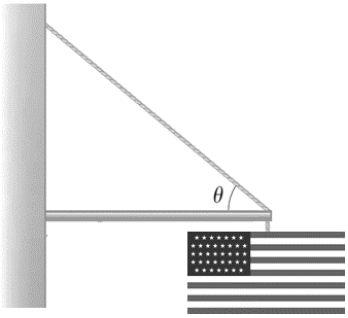


7. The figure above shows a rod that is fixed to a horizontal surface at pivot P. The rod is initially rotating without friction in the counterclockwise direction. At time t, three forces of equal magnitude are applied to the rod as shown. Which of the following is true about the angular speed and direction of rotation of the rod immediately after time t?

	Angular Speed	Direction of Rotation
A)	Decreasing	Counterclockwise
B)	Decreasing	Clockwise
C)	Increasing	Counterclockwise
D)	Increasing	Clockwise

8. A horizontal boom is constructed to support a 150 N flag (the best flag). The horizontal boom itself weights 50 N and is 2 m long. Determine the tension in the supporting cable if the cable makes an angle of 30° with the horizontal boom. America.

A) 300 N
B) 350 N
C) 250 N
D) 200 N

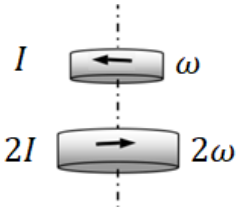


9. A spherical star is spinning with some angular velocity when it collapses to half its original radius without any loss of mass. Assume that the star has uniform density before and after collapse. What happens to the angular momentum and rotational kinetic energy of the star?

A) The angular momentum stays the same. The kinetic energy decreases.
B) The angular momentum and kinetic energy stays the same.
C) The angular momentum stays the same. The kinetic energy increases.
D) The angular momentum increases. The kinetic energy increases

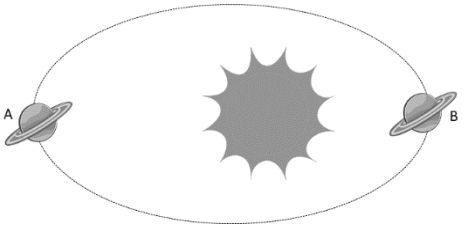
10. A disc of momentum of inertia $2I$ is spinning counterclockwise at a speed of 2ω. A disc of momentum of inerta I is spinnign clockwise at ω on the same axle as shown. The smaller disc falls onto the bigger one and the discs stick together in a perfectly inelastic collision. What is the kinetic energy of the two discs after colliding?

A) $\frac{3}{2}I\omega^2$ B) $\frac{25}{6}I\omega^2$ C) $\frac{9}{5}I\omega^2$ D) $\frac{27}{50}I\omega^2$

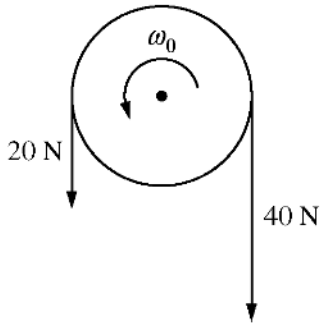


11. A planet orbits a star in an elliptical orbit. Points A and B are parts of its orbit, and point A is further from the star than point B. Which of the following is true about the angular momentum, L, of the planet about the star at the two points?

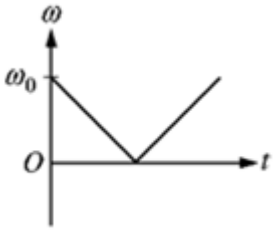
A) L is more at B since the planet moves faster at B.
B) L is the same at both points since there is no outside torque.
C) L is more at A since the planet has more moment of inertia at A.
D) L is the same at both points since the plante has a constant orbital speed.



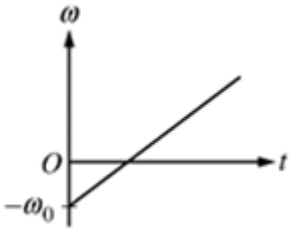
12. A disk is initially rotating counterclockwise aroudn a fixed axis with angular speed ω_0. At time t = 0, the two forces shown in the figure are exerted on the disk. If counterclockwise is positive, which of the following could show the angular velocity of the disk as a function of time?



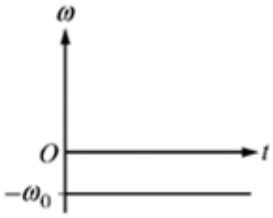
A)



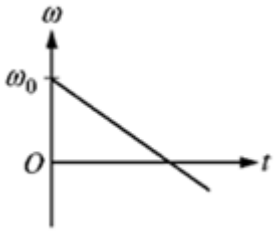
B)



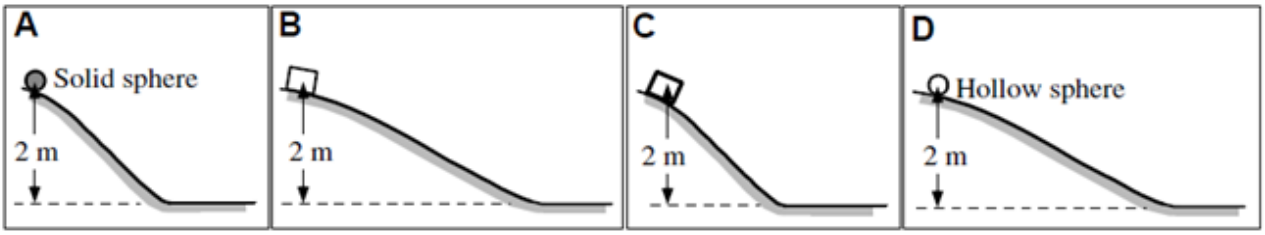
C)



D)



13. In each case shown below, a 1.0 kg object is released from rest on a ramp of height 2 m from the bottom. Both spheres roll without slipping, and the blocks slide without friction. The ramps are identical in case A and C. The ramps in cases B and D are identical, but not as steep.



Rank the speed of the objects when they reach the horizontal surface at the bottom of the ramp.

A) B = C > A > D B) D> A > B = C C) C > B > A > D D) B = C > D > A

14. A bowling ball rolls without slipping across a lane. Which of the following explains why the net work done by friction is zero?

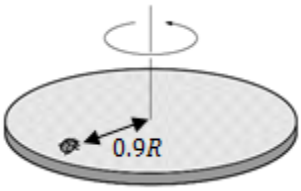
A) Friction does not cause a torque about the ball's center of mass.
B) Friction only affects the ball's rotational motion, and work is linear force times distance.
C) The linear and rotational work done by the bowling ball cancel each other out.
D) An object can only roll without slipping if the force of friction is zero. If the frictional force is zero, the work is zero.

15. The wheel ($I = \frac{1}{2}mr^2$) on the ground keeps on rolling without slipping along a horizontal surface. What percentage of its total kinetic energy is line kinetic energy?

A) 25% B) 40% C) 50% D) 75%

Free Response. **You must show all steps** required to arrive at the correct answer for the problems below, including any diagrams.

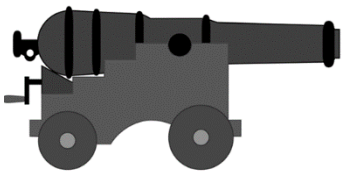
16. A circular plate of mass M=2.0 kg and radius $R = 1.0\ m$ is pivoted above its center and rotates with angular speed ω(with nothing on the plate). The plate has rotational inertia ($\frac{1}{2}MR^2$). As shown, a bug is placed on the plate a distance of 0.9R from the center of the plate. The mass of the bug is 0.4 kg. As a result, the angular velocity of plate changes.



a) Calculate the new angular velocity of the plate with the bug on it.

b) The bug walks towards the center of the plate. Describe how the angular velocity of the plate's spinning changes as the bug walks. Justify your answer.

17. During an epic pirate battle, a cannon is fired horizontally out a cannon as shown. The cannon leaves the cannon with a linear speed v and is spinning initially with an angular velocity of ω.



a) How does the total linear velocity of the cannon, v, change while the cannon ball is in flight?

_____Increase _____Decrease _____Stays the same.

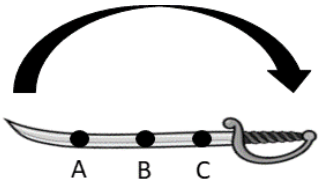
Justify your answer.

b) How does the angular velocity, ω change while the cannon ball is in flight?

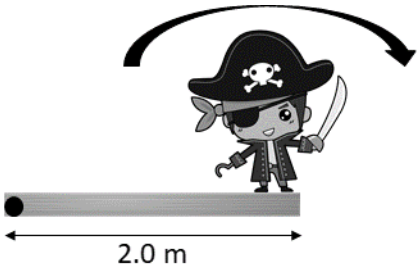
_____Increase _____Decrease _____Stays the same.

Justify your answer.

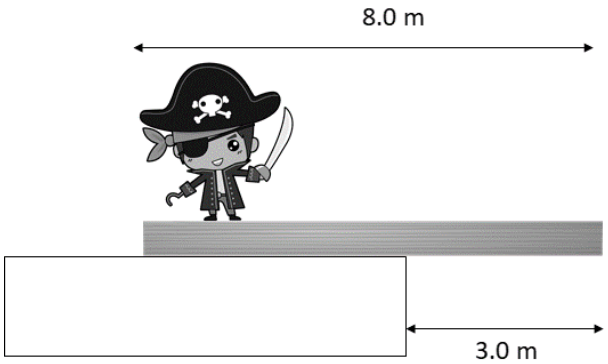
c) During the epic battle, Captain Gol D Roger spins his sword in the direction shown. His sword has a light blade and heavier handle. Which marked should he hold the sword in order to spin it most easily? Justify your answer.



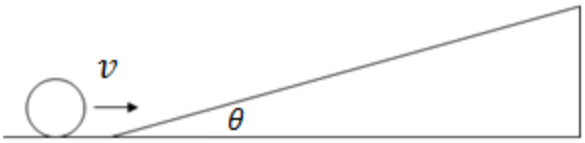
d) After the epic battle, a pirate walks over a 2.0 m long trap-door as shown. The instant he is standing at the end of the door far from the hinge, the trap door begins to rotate downwards. The uniform trap door has a mass of 30 kg can be treated as a rod pivoted on its end ($I=\frac{1}{3}mL^2$). The pirate is kawaii, has a mass of 60 kg and can be treated as a point mass on the far right end of the door. Find the initial angular acceleration of the door.



e) After being caught, the kawaii pirate is made to walk a plank as shown. The uniform planks is 8.0 meter long with a mass of 100 kg rests and rests horizontally on the ship's deck and is extended 3.0 over the edge as shown. The pirate is still kawaii and has a mass of 60 kg. How far can the pirate walk past the edge of the ship's deck before the plank begins to tip?



18. A large spherical basketball ($I = \frac{3}{8}mr^2$) is rolled up an incline that makes an angle of θ with the horizontal as shown. The basketball has a mass of m and radius r It enters the incline with an initial linear velocity of v.



a) Explain why the normal force does affect the rotation of the ball.

b) Determine an expression for the maximum height reached by the basketball.

c) How would the answer to b) change the incline were frictionless? Explain your reasoning in one complete sentence.

d) Derive an expression for the force of friction of the ball as it rolls uphill.