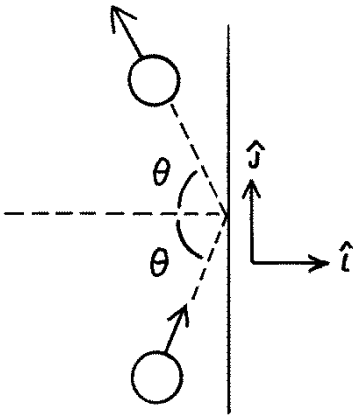
Exam 2 Sample Questions

1. You observe a wheel that is rotating clockwise (as you view it) and speeding up its rate of rotation. Which is true?

A. The angular velocity points away from you and the angular acceleration is zero.
B. The angular velocity points away from you and the angular acceleration points toward you.
C. Both the angular velocity and the angular acceleration point away from you.
D. The angular velocity points towards you and the angular acceleration is zero.
C. Both the angular velocity and the angular acceleration point towards you.

2. A ball of mass m strikes a massive wall at speed v_o at an angle θ with the normal to the wall. It bounces off with the same speed and angle. If the ball is in contact with the wall for a time t, what is the magnitude of the impulse applied to the ball by the wall?



A. $2mv_0$

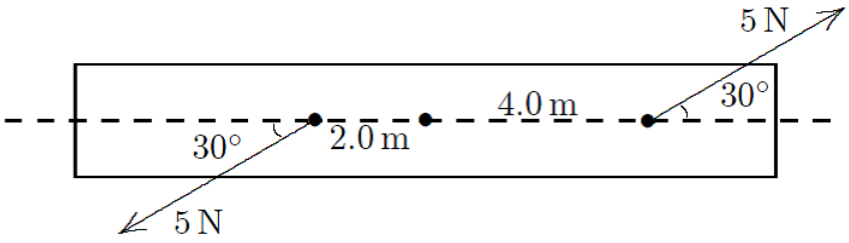
B. $2mv_o \sin\theta$

C. $2mv_o \cos\theta$

D. $mv_0 \tan\theta$

E. mv_0/t

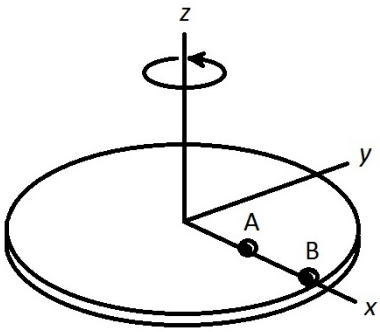
3. A block is pivoted about its center. A 5.0 N force is applied 4.0 m from the center and another at 2.0 m from the center. Both forces act at 30˚ as shown. The magnitude of the net torque about the center is



A. 0 N·m
B. 4.3 N·m
C. 5.0 N·m
D. 13 N·m
E. 15 N·m

4. Point A is halfway between point B and the axis of rotation of a solid circular platform as shown. Given these three statements;

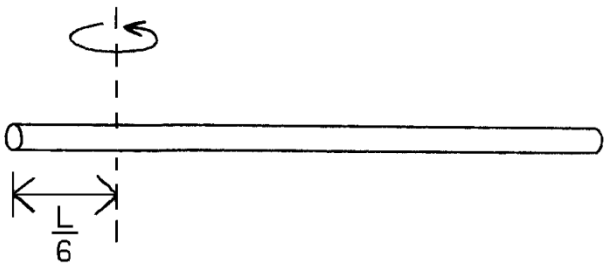
I. Point A has twice the **angular** velocity of point B.
II. The **angular** velocity vector is in the positive $\hat{x}$ direction.
III. Point A and point B have the same **angular** acceleration.



Which of the above statements are true?

A. I only
B. II only
C. III only
D. I and III only
E. II and III only

5. Consider a long thin rod of uniform density (mass M and length L) that is rotated about an axis that is perpendicular to its length and located one sixth of the length from one end, as shown in the diagram. What is the moment of inertia for the rod about this axis?



A. $\frac{7}{36}ML^2$

B. $\frac{11}{36}ML^2$

C. $\frac{13}{36}ML^2$

D. $\frac{15}{36}ML^2$

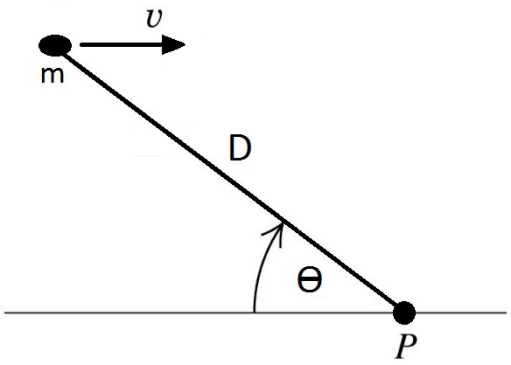
E. None of the above

6. A wheel is spinning at 18 rad/s but is slowing with a **time-varying** angular acceleration that has a magnitude given by (4.0 rad/s^3) t. The wheel will slow down to half its initial speed in a time of

A. 1.5 s
B. 2.1 s
C. 2.3 s
D. 3.0 s
E. 4.5 s

7. A rock is thrown into the air. At the very top of its trajectory, the velocity of the rock is level with the ground and has a magnitude υ. A person standing on the ground at point P observes the rock at angle θ above the horizon as shown. The angular momentum of the rock about the point P at the moment it's at the top of its trajectory has a magnitude given by

A. $\boldsymbol{mv}$
B. $\boldsymbol{mvD \sin \theta}$
C. $\boldsymbol{mvD \cos \theta}$
D. $\boldsymbol{mvD \tan \theta}$
E. 0 (zero)



8. A uniform rod of mass m and length L swings downward, pivoting about a point at the top of the rod. Which of the following is a true statement as the rod swings freely downward?

A. The angular momentum of the rod about the pivot is conserved.

B. The rod has a constant torque acting on it as it swings

C. The rod swings down with a constant angular velocity.

D. The rod swings down with a constant angular acceleration.

E. None of the above.

9. Two identical railway cars with the same mass are travelling in the same direction along a straight and level section of rail. One car is travelling at a speed of $\boldsymbol{3v}$ and the other at a speed of $\boldsymbol{v}$. The faster car strikes the back of the slower car and they link together. What is the final speed of the combined pair?

A. $\boldsymbol{2.00\,v}$
B. $\boldsymbol{2.24\,v}$
C. $\boldsymbol{3.00\,v}$
D. $\boldsymbol{3.16\,v}$
E. $\boldsymbol{4.00\,v}$

10. Two vectors **A** and **B** are shown. What is the direction of **A x B** ?

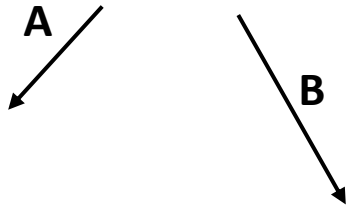
A. Into the page

B. Out of the page

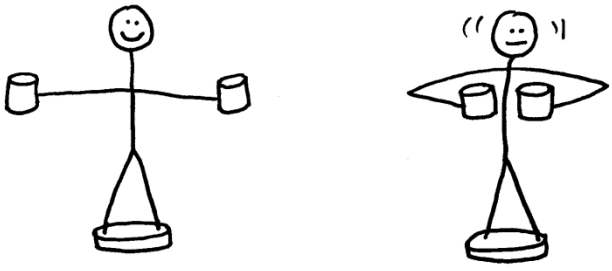
C. Along **A**

D. Along **B**

E. Towards the bottom of the page



11. A student stands upon a freely-rotating platform with some initial angular speed, holding weights in both hands. The student then pulls the weights inwards. Which of the following is a true statement concerning the student and the weights?



A. The moment of inertia decreases and the angular speed also decreases

B. The moment of inertia increases and the angular speed also increases

C. The moment of inertia increases, and he angular speed decreases

D. The moment of inertia decreases and the angular speed increases

E. None of the above.

12. The vector torque about the origin due to a force $\vec{F} = (1N)\hat{i} + (-3N)\hat{j}$ acting at the point $\vec{R} = (2m)\,\hat{i}$ would be

A. $\vec{\tau} = (2N \cdot m)\,\hat{k}$

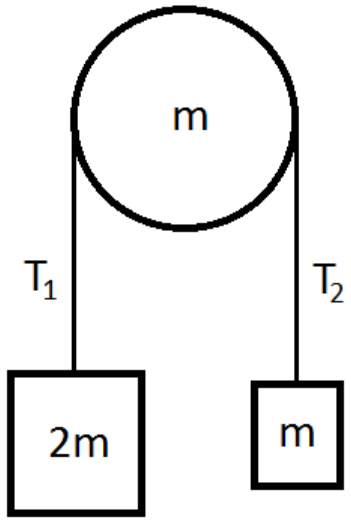
B. $\vec{\tau} = (-6N \cdot m)\,\hat{k}$

C. $\vec{\tau} = (2N \cdot m)\,\hat{i}$

D. $\vec{\tau} = (6N \cdot m)\hat{k}$

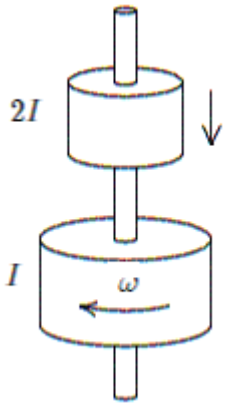
E. $\vec{\tau} = \vec{0}\ N{\cdot}m$

13. Two blocks are suspended by a cord over a pulley. The masses of the blocks and the pulley are as indicated in the diagram. The blocks are free to move and the ideal cord moves over the pulley without slipping or sliding. There is no friction in the pulley axle. Which of the following is the correct ranking as the 2m mass accelerates downwards?



A. $mg < T_2 < T_1 < 2\,mg$
B. $mg = T_2 = T_1 = 2\,mg$
C. $mg < T_2 = T_2 < 2\,mg$
D. $mg = T_2 < T_1 = 2\,mg$
E. None of the above

14. Two disks are mounted on low-friction bearings on a common shaft. The bottom disk has a rotational inertia I and is spinning with angular velocity ω. The top disk has rotational inertia 2I and is initially at rest as shown. The top disk is dropped onto the bottom disk along the shaft. They couple together and have a final common angular velocity of:



A. $\omega/3$
B. $\omega/\sqrt{3}$
C. $\omega/2$
D. $\omega/\sqrt{2}$
E. $2\omega/3$

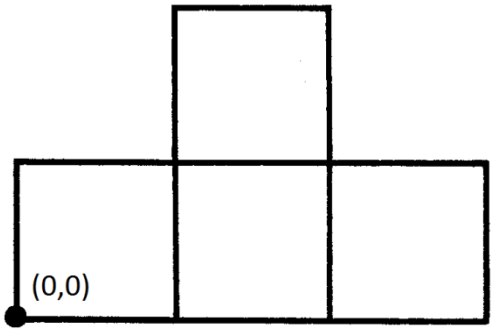
15. A force is given by $F(t) = 3.0\ t^2$. It acts on an object from t = 0 until t = 3.0 s. The object has a mass of 9.0 kg and starts from rest. What is the speed of the object at 3.0 seconds?

A. 2.4 m/s
B. 3.0 m/s
C. 5.2 m/s
D. 18 m/s
E. 27 m/s

16. A wheel is initially rotating at 18.0 rad/s and slows down with a **<u>non-constant</u>** angular acceleration that has a magnitude given by (2.00 rad/s^4) t^2. The wheel will stop in a time of

A. 2.00 s
B. 2.08 s
C. 2.62 s
D. 3.00 s
E. 9.00 s

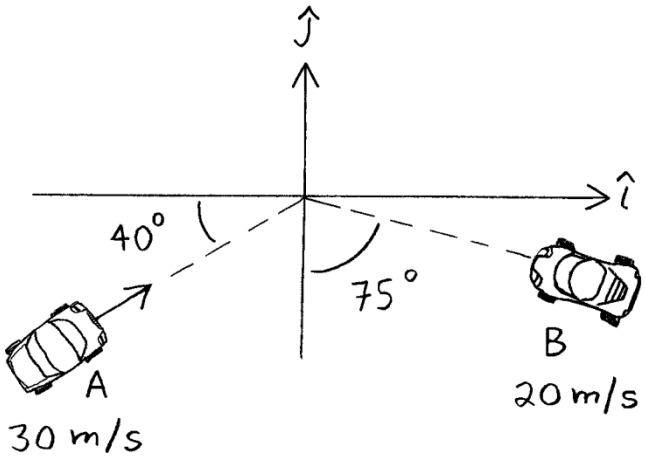
17. Four squares of equal mass and sides of length L are arranged as shown with the origin at the lower left. The (x,y) coordinates of the center of mass of the object are:



A. (3L/2, 3L/16)
B. (3L/2, 3L/8)
C. (3L/2, 3L/4)
D. (3L/2, L)
E. (3L/2, 3L/2)

1:

Car A of mass 800 kg and car B of mass 1200 kg are headed towards each other as shown (top view). Immediately before impact, car A has a speed of 30.0 m/s and makes and angle of 40° with the x-axis as shown. Car B has a speed of 20.0 m/s and makes and angle of 75° with the y-axis as shown. After the collision, the cars stick together and move as one.



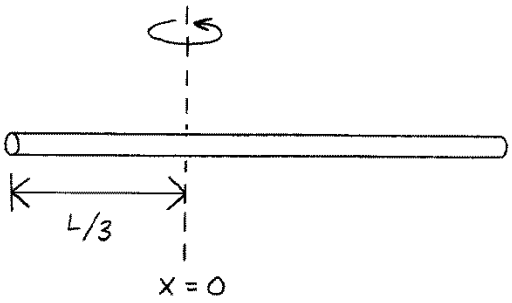
a) What is the velocity of the cars immediately after the collision, expressed in unit vector component (Cartesian) notation.

b) What is the force that Car A exerts on Car B during the collision, if the collision lasts 0.420 seconds? Express your answer in unit vector component (Cartesian) notation.

c) Is the collision elastic or inelastic? Justify you answer with some sort of calculation.

2:

A thin rod has a non-uniform density given by $\boldsymbol{\lambda} = (\mathbf{4.00}\frac{\boldsymbol{kg}}{\boldsymbol{m^2}})\boldsymbol{x} + (\mathbf{3.00}\frac{\boldsymbol{kg}}{\boldsymbol{m}})$ and a total length L = 5.00 m. It is rotated about an axis located at L/5 as shown, where x = 0 is the axis of rotation.



(a) Calculate the moment of inertia, clearly showing all steps to receive full credit.

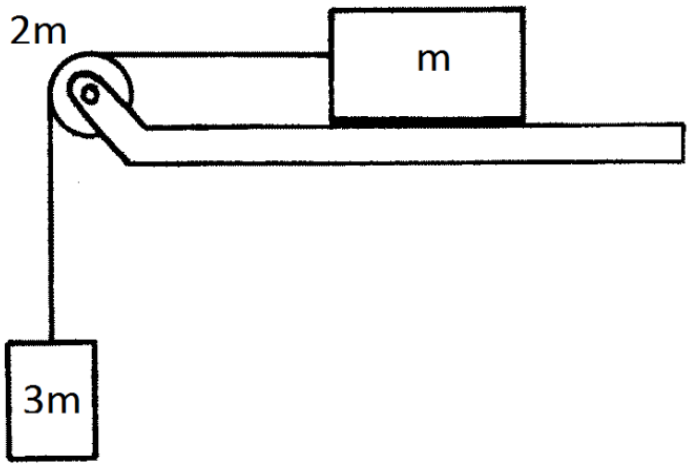
(b) Calculate the total mass of the rod.

(c) Is the MOI of this rod larger or smaller than that of a uniform rod pivoted about the same axis? Justify your answer.

3:

A modified Atwood's machine consists of a block of mass $\boldsymbol{m}$ sliding on a rough table with kinetic friction coefficient 0.5. A hanging mass $\boldsymbol{3m}$ pulls it by a massless string. The string passes over a pulley of mass $\boldsymbol{2m}$. The pulley is a uniform disk of radius $\boldsymbol{R}$. There is no slipping or sliding of the string over the pulley.

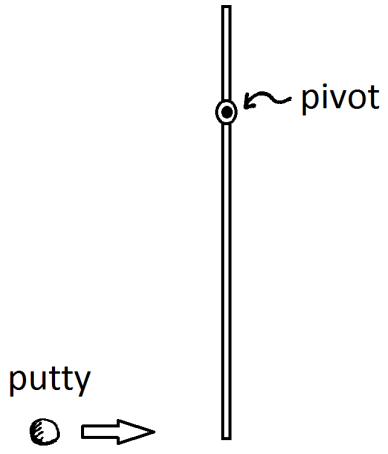
It is required to draw all relevant free body diagrams for the two masses and the pulley.



Find the magnitude of the acceleration of the system when released from rest, as a multiple of the gravitational acceleration g. Also find the tension in the vertical portion of the string and the tension in the horizontal portion of the string, both as multiples of mg.

4:

A long thin rod of total length 4.00 m is pivoted 1.00 m from the top end. It is hung vertically and initially at rest as shown. The rod has a non-linear mass density given by $\boldsymbol{\lambda = (3 + 15x^2)}$ kg/m, where $\boldsymbol{x = 0}$ is at the pivot. A small piece of putty of mass 0.200 kg is shot horizontally into the lower end of the rod, striking it with a speed of 20.0 m/s. The putty sticks to the rod.



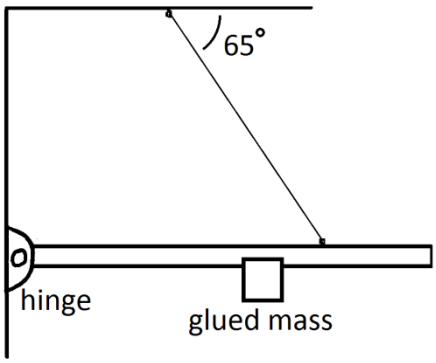
a) Calculate is the moment of inertia I of the stick about the pivot.

b) Calculate the angular velocity ω of the stick the instant after the putty strikes and sticks to it.

c) If you were asked to find the maximum angle that the rod/putty combination would make with the vertical after the collision, explain <u>in words</u> how you would solve this problem. Do not actually solve. Maximum 3 sentences.

5:

A long uniform horizontal rod of total length 10.0 m and total mass 150 kg it attached to a wall by a hinge (pivot). It is supported by a wire attached at 7.00 m from the hinge. The wire makes and angle of 65° with the ceiling as shown.



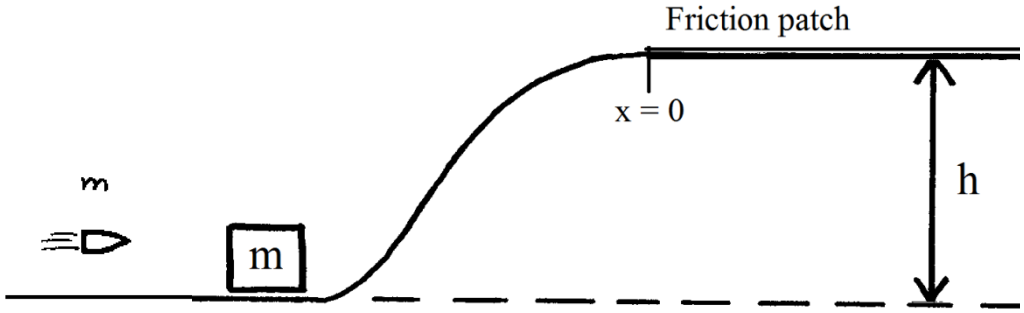
The maximum tension allowed in the wire before it will break is 2016 N. You want to glue a block of mass 60.0 kg on the rod as far away from the hinge as possible.

a) Calculate the maximum distance away from the hinge that you can glue the block before the string breaks.

b) When the block is in this maximum position, the string breaks. The rod/mass combination swings downwards, starting from rest. Find the angular speed of the rod/mass combination just as they reach the vertical position.

6:

A bullet of mass m is shot with an initial speed v_o into a block of mass M that is initially at rest. It collides and sticks inside of the block. After the collision, the bullet and block combination move up a frictionless hill to a height h above the ground. Once at the top of the hill, there is a rough patch with uniform friction characterized by the kinetic coefficient μ_k.



How far does the bullet/block combination travel through the rough patch before coming to rest? Write your answer for this distance z in terms of only the variables m, M, v, h, μ_k and g.