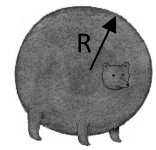
AP Physics 1 Name: ____

Unit 5&6 Test: Rotation

Directions: **Show the steps** required to arrive at the answer (if applicable).

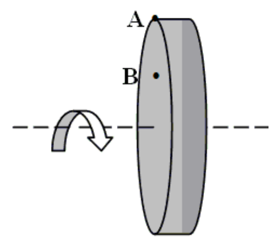
1. A bear is spinning (at time t = 0) at an angular velocity of 60 rad/s and an angular acceleration given by of $-3\ 1/s^2$. The bear has a moment of inertia of 2.0 $kg\ m^2$. Assume spherical bear.



a) Calculate the number of revolutions the bear makes while slowing down.

b) Calculate the work done on the bear while it slows down.

2. The wheel in the sky keeps on turning. The wheel spins at constant speed. Points A and B are points on the wheel. Point A is on the rim of the wheel, while B is halfway between the center and the edge of the wheel.



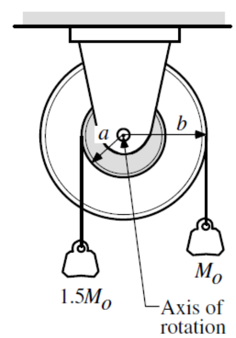
a) Which point (if any) has a greater angular velocity? Briefly justify your answer.

b) Which point (if any) has a greater linear velocity? Briefly justify your answer.

c) Which point (if any) has a greater centripetal acceleration velocity? Briefly justify your answer.

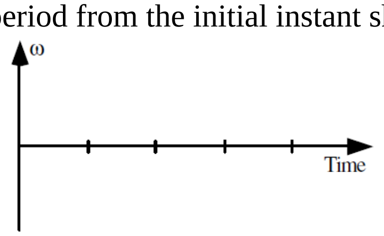
3. Two pulleys with different radii (*a* and *b*) are attached to one another so that they rotate together. Each pulley has a string wrapped around it with a weight hanging from it. The pulleys are free to rotate about an axis through the center. The radius of the larger pulley is twice the radius of the smaller one ($b = 2a$). A student states:

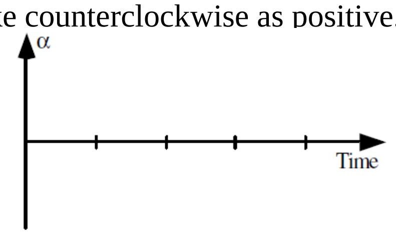
"The larger mass is going to create a counterclockwise torque and the smaller mass will create a clockwise torque. The torque for each will be the weight times the radius, and since the radius for the larger pulley is double the radius of the smaller, and the weight of the heavier mass is less than double the weight of the smaller one, the larger pulley is going to win. The net torque will be clockwise, and so the angular acceleration will be clockwise."



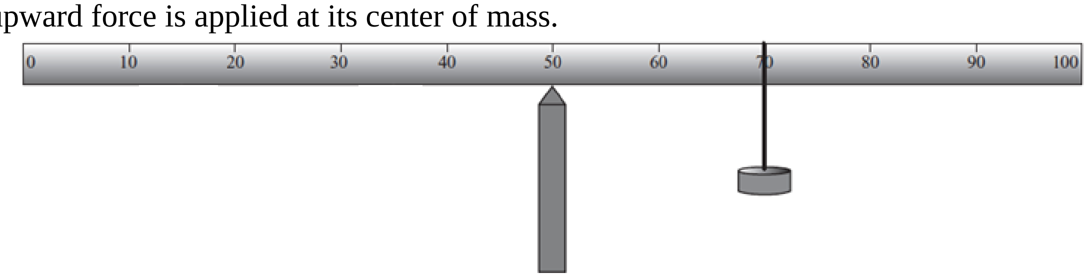
a) What, if anything, is wrong with this contention? If something is wrong, explain how to correct it. If this contention is correct, explain why.

b) On copies of the graphs below, sketch the angular velocity (ω) and angular acceleration (α) versus time for the period from the initial instant shown. Take counterclockwise as positive.





3. The uniform meterstick (mass = 0.5 kg) below has an object with mass 2.0 kg hanging at the 70 cm mark as shown. An upward force is applied at its center of mass.

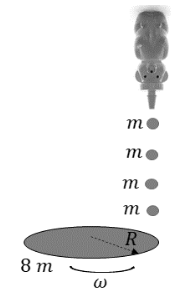


a) The system is released from rest. Treat the meter stick as a rod pivoted at the center ($I=\frac{1}{12}mL^2$). Calculate the direction and magnitude of the meter stick's angular acceleration.

b) Suppose you are given another weight of mass 0.75 kg. Where should the new weight be hung in order for the meter stick to be in equilibrium?

c) Suppose the 2.0 kg weight is moved to the right and the new 0.75 kg is kept at its position from part a. In order to preserved equilibrium, should mass of the 0.75 kg weight be increased, decreased, or kept the same? Justify your answer.

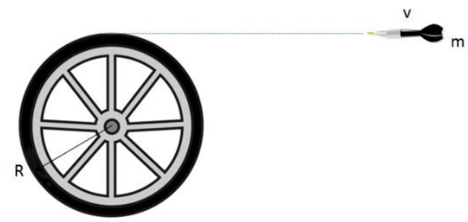
5. A solid disc of mass $8m$ and radius R is rotating at an angular velocity of ω ($I_{disc} = \frac{1}{2}MR^2$). 4 drops of honey, each of mass m, are dripped onto the disc and stick to it, at the very outer edge of the disc.



a) Determine an expression for the angular velocity of the disc after all 4 drops of honey stick to it.

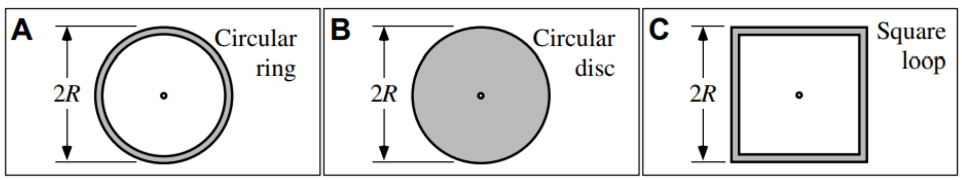
b) Do the drops of honey do positive, negative, or zero work on the disc? Briefly justify your answer.

6. (A dart of mass m is fired at a speed v towards a bicycle of mass $24m$ as shown on the right. The dart hits the tire at the edge and becomes embedded in it, causing the tire to rotate. The wheel has a radius R and a moment of inertia given by $I = \frac{3}{5}MR^2$.



a) Determine an expression for the initial moment of the dart above the center of mass of the wheel before the collision.
b) Determine an expression for the angular speed of the tire after the dart strikes.
c) How would the magnitude of b) change if the wheel had the same mass, but half the radius and the dart were to hit at the same speed at the edge? Justify your answer qualitatively or with algebra.

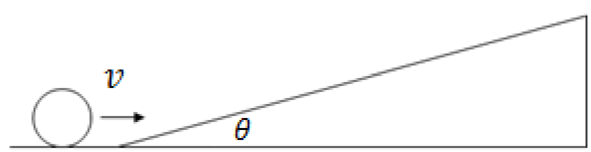
7. Three flat objects (circular ring, circular disc, and square loop) have the same mass M and the same outer dimension. The center of each represents the axis of rotation.



a) Rank the torque required to give each one a given angular velocity from least to greatest. Explain your reasoning.

b) The circular ring rolls without slipping along a rough surface at constant speed. State why it can roll at constant velocity.

8. A large spherical basketball ($I = \frac{5}{8}mr^2$) 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) Draw and label all the forces acting on the ball as it rolls up. Draw each force at the point where it acts.
b) For your forces in a: (you need not justify this parts)

i. identify that forces that affect the ball's linear acceleration.

ii. identify that forces that affect the ball's angular acceleration.

b) Determine an expression for the acceleration of the basketball.
c) Find the maximum height up the incline the basketball rolls.
d) How would the maximum height of the basketball compare in the following cases? Give a short justification for your answer:

i) The basketball were solid? (assume basketballs are hollow)

ii) The basketball slides up the incline instead of rolling?