Name:

Algebra Based Physics
Torque and Angular Mechanics test (P)

You must always show all work and include the correct sign and correct units for all answers. Assume + is up or right.

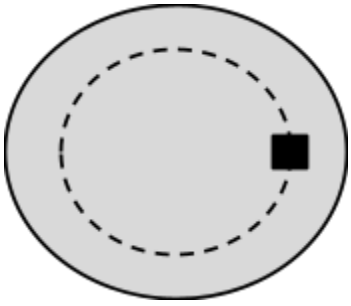
1. A cylindrical merry go round has a mass M and a radius R and is spinning with an angular velocity ω_o. When the ride ends it takes the merry go round 5 revolutions to stop. What is the magnitude of the angular acceleration (assumed constant) of the merry go round?

A. $5\omega_o^2/(MR)$
B. $2\omega_o^2/(MR^2)$
C. $\omega_o^2/(10\pi R)$
D. $\omega_o^2/(20\pi)$

2. Translate the following three linear formulas with linear variable into angular formulas with angular variables:

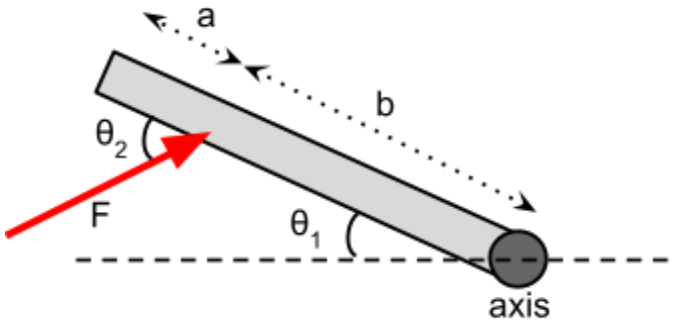
Linear formula	**Angular formula**
Power = Fv	Power = **τω**
Work = Fd	Work = **τΔθ**
Impulse = ΣFΔt	Angular Impulse = **τΔt**

3. A mass M sits on a turntable and rotates in a circle of radius R without slipping at a constant speed S as seen in the birds eye view to the right. Which statement is most accurate about the accelerations of the block during its motion around the circle?



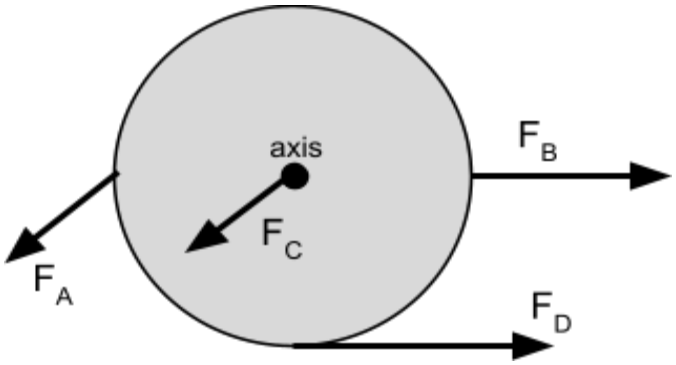
A. centripetal acceleration is nonzero, tangential acceleration is nonzero, angular acceleration is zero
B. centripetal acceleration is zero, tangential acceleration is nonzero, angular acceleration is nonzero
C. centripetal acceleration is nonzero, tangential acceleration is zero, angular acceleration is nonzero
D. centripetal acceleration is nonzero, tangential acceleration is zero, angular acceleration is zero

4. What would be the correct expression for the torque exerted by the following force F measured about the axis shown?



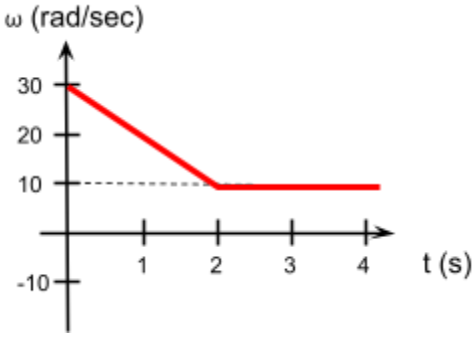
A. $(a+b)F\sin\theta_1$
B. $bF\sin\theta_2$
C. $(a+b)F\sin\theta_1$
D. $aF\sin\theta_2$

5. A sphere has many forces acting on it. Select the **2 choices** below that represent forces which provide no torque on the sphere about axis which passes through the center of the sphere.



A. F_A
B. F_B
C. F_C
D. F_D

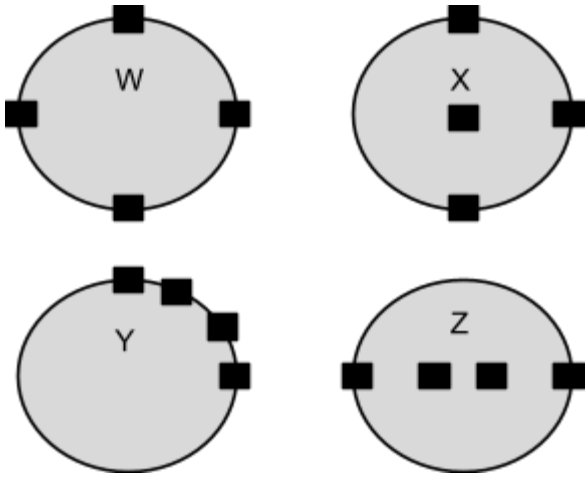
For Questions 6-7: A cylinder with a radius 3m and a mass 4kg spins about its axis. The graph shown gives the angular velocity of the cylinder as a function of time. The moment of inertia of a cylinder is ½MR^2.



6. What is the torque exerted on the motor at t=1sec?
A. 180 Nm
B. 4,800 Nm
C. 10 Nm
D. 0.03 Nm

7. Through what angle did the motor spin between 2-4sec?
A. the motor did not spin between 2-4 seconds
B. 2 radians
C. 10 radians
D. 20 radians

8. Four identical cylinders have four identical black masses attached in different places. Rank the moment of inertia of the cylinder-masses systems from largest moment of inertia to smallest.



A. $I_Z > I_W > I_Y > I_X$
B. $I_W = I_Y > I_X > I_Z$
C. $I_Z = I_W = I_Y > I_X$
D. $I_Y = I_W > I_Z > I_X$

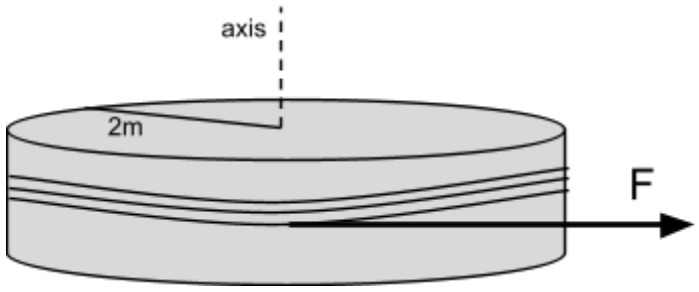
9. When an ice skater is spinning on frictionless ice and brings her arms in, what happens to the following quantities associated with the ice skater?

	Moment of inertia	Angular Momentum	Total Kinetic Energy
A.	increases	constant	increases
B.	increases	decreases	increases
C.	**decreases**	**constant**	**increases**
D.	decreases	constant	constant

10. You want to determine the mass of a cylindrical merry go round that has a radius of 2m. You can not remove the merry go round from its support on the ground to weigh it so you devise an experimental procedure to determine the mass of the merry go round.

You use a motor which can pull tangentially with specific constant force settings on a rope wound around the edge of the merry go round. You pull with specific constant force setting and measure the time it takes the merry go round to rotate through 4 full revolutions with that force setting. The data is given in the following chart.

F (Force setting)	**T** (Time for 4 revolutions)
500 N	8.7 sec
1000 N	6.1 sec
1500 N	5.0 sec
2000 N	4.3 sec
2500 N	3.9 sec



a. What combination of variables could you plot (y=?, x=?, m=?) to get a linear relationship on following graph that will allow you to determine the mass of the merry go round. Give your answers symbolically.

$$\alpha = \frac{\Sigma\tau}{I} = \frac{RF}{\frac{1}{2}MR^2} = \frac{2F}{\frac{1}{2}M(2)^2} = \frac{F}{M}$$ and $$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$$ or

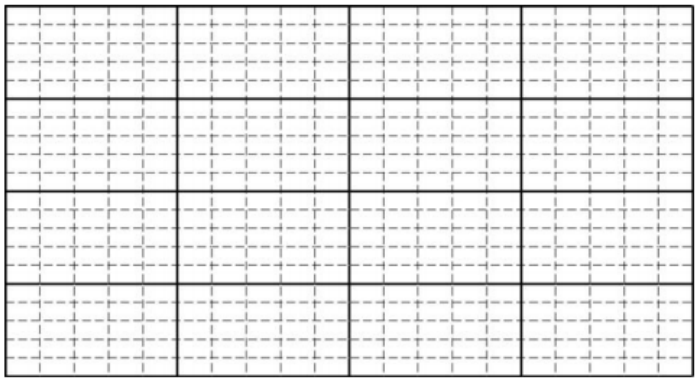
$$8\pi = \frac{1}{2}\alpha T^2$$

so subbing in the alpha you have for "sum of the torque" you get $$8\pi = \frac{1}{2}\frac{F}{M}T^2$$

$$F = \frac{16\pi M}{T^2}$$

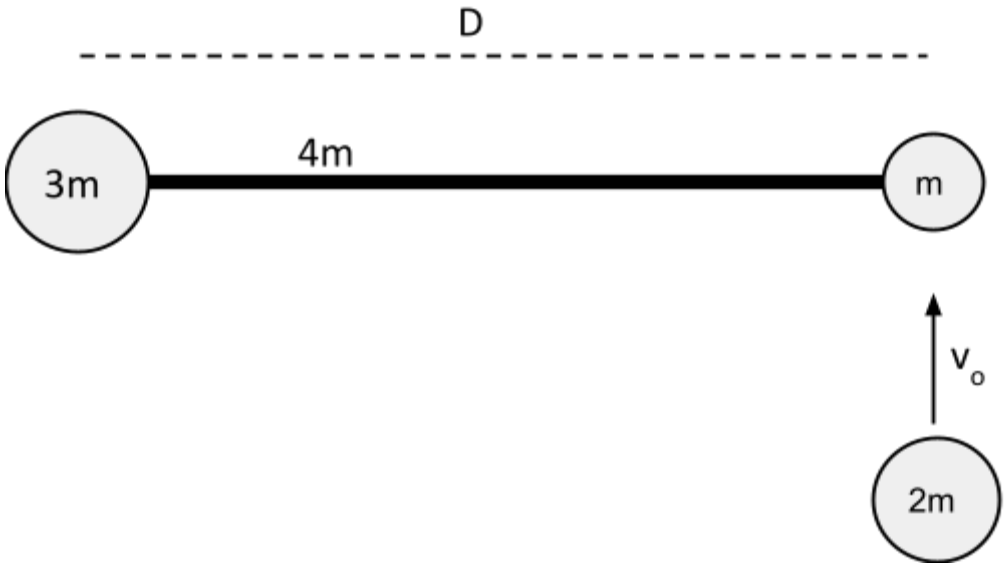
y = **F** x = **1/T²** m = **16πM**

b. Label the axes below, plot data points for your choices from part a., and draw a best fit line through the data.



c. Find the slope of your best fit line and use that slope to determine a value for the mass of the merry go round.

11. A massless rod of length D is sitting at rest on a frictionless table and has a sphere of mass 3m and mass m attached to its ends. The view below is a birds eye view from above the table. A mass 2m moving with speed v_o strikes the mass m and sticks to it. The entire system then translates and rotates freely.



a. How far from the left end of the rod is the center of mass of the system after the mass 2m has stuck to the other mass m?

D/2

b. What will be the speed of the center of mass of the system after the mass 2m has struck the other mass m.

$p_i = p_f$
$2mv_o = (6m)v_f$ so **$v_f = v_o/3$**

c. What will be the angular velocity of the system about its center of mass after the 2m mass has stuck to the mass m?

$L_i = L_f$
$2mv_o(D/2) = [3m(D/2)^2 + 3m(D/2)^2]\omega_f = (3mD^2/2)\omega_f$ **or** **$\omega_f = 2v_o/(3D)$**

d. After the 2m mass has struck the mass m, how long does it take for the system to make 10 revolutions?

$\omega_f = \frac{\Delta\theta}{t}$ so $t = \frac{\Delta\theta}{\omega} = \frac{3(20\pi)}{2v_o} = \frac{30D\pi}{v_o}$