Problem Set #8 Rotational Motion and Energy, Project Connections
Due December 2 2019

Name:___________________________________

I worked with:

Translational:

Position (constant velocity)	$s(t) = s_0 + v_0t$
Position:	$s(t) = s_0 + v_0t + ½ at^2$
Average Velocity:	$v_{avg} = \frac{s_2 - s_1}{t_2 - t_1}$
Velocity:	$v(t) = v_0 + at$
Final Velocity (time):	$v_f = v_0 + at_f$
Final Velocity (position):	$v_f^2 = v_0^2 + 2a\Delta s$
Acceleration:	$a = \frac{v_2 - v_1}{t_2 - t_1}$
Force:	$F = ma$
Force due to Gravity on Earth:	$F = mg$
Elastic Force/Spring Force:	$F = -kx$
Force due to Kinetic Friction:	$F = \mu_k F_N$
Force due to Static Friction:	$F = \mu_s F_N$
Acceleration due to gravity on Earth:	$g = 9.8\ m/s^2$
Universal Gravitation:	$F = \frac{GMm}{r^2}$
Gravitational Potential Energy:	$GPE = mgh$
Kinetic Energy:	$KE = ½ mv^2$
Elastic/Spring Potential Energy:	$EPE = ½ kx^2$
Gravitational Constant:	$G = 6.67 \times 10^{-11}$
Avogadro's Number:	6.022×10^{23}

Rotatational

Angular Displacement:	$\boldsymbol{\theta}(t) = \boldsymbol{\theta}_0 + \boldsymbol{\omega}_0 t + ½ \boldsymbol{\alpha} t^2$
Angular Velocity:	$\boldsymbol{\omega}(t) = \boldsymbol{\omega}_0 + \boldsymbol{\alpha} t$
Angular Velocity (time):	$\boldsymbol{\omega}_f = \boldsymbol{\omega}_0 + \boldsymbol{\alpha} t_f$
Angular Velocity (displacement):	$\boldsymbol{\omega}_f^2 = \boldsymbol{\omega}_0^2 + 2\boldsymbol{\alpha}\Delta\boldsymbol{\theta}$
Angular Velocity (trans. velocity):	$\boldsymbol{\omega} = rv$
Centripetal Acceleration:	$a_c = v^2/r$
Centripetal Force:	$F = ma_c = mv^2/r$
Torque:	$\boldsymbol{\tau} = I\boldsymbol{\alpha}$
Kinetic Energy:	$KE = ½ I\boldsymbol{\omega}^2$

1. Check to see if the following equations are correct by using unit analysis:
    a. $x_0 + v_0 + ½ a t^2 = x$
    b. $v_0 + at = v$
    c. $(v - v_0)/x = a$

2. Elmira, New York boasts of having the fastest carousel ride in the world. The merry-go-round at Eldridge Park takes riders on a spin at 18 mi/hr (8.0 m/s). The radius of the circle about which the outside riders move is approximately 7.4 m.

    a. Determine the time for outside riders to make one complete circle.

    b. Determine the acceleration of the riders.

3. Explain how you could estimate the instantaneous velocity of your kinetic sculpture as it navigates the race course. Please make sure to use words such as secant, slope, and tangent in your answer.

4. Your teams kinetic sculpture has a mass of 8 kg. It makes it through the first part of the race course and reaches the downhill/ramp portion with a velocity of 0.5 m/s. The height of the ramp is 3 meters and the length of the ramp is 5 meters. What is your sculptures final velocity at the bottom of the ramp? (assume no friction and that your sculpture has 4 tires with a radius of 4 cm)

5. (Honors) Repeat the calculation above, except now account for friction on the ramp. Assume that μ_k= 0.02.
    a. What is your sculptures velocity at the bottom of the ramp?
    b. How much energy was lost to Friction?