CSUC Spring Term 2020 Physics 204A **Portfolio Problem for Week 13:**

Due Monday, April 27 by Noon on our class Blackboard site: 202-PHYS204A-05-4569

Dear Class: This is the fifth (and Week13) Portfolio Problem Set. The first is a rotation problem mixed with a simple 1-D translation problem. Both emphasize *universal equations of motion*. Draw lots of pictures! Don't rush! The answer is fun – and you will have learned a ton about problem solving … and bowling! This is an open book and unlimited time exercise.

Let's Go Bowling !

A bowler throws a bowling ball of radius R = 11 cm down a bowling lane. It has an initial linear velocity of $\mathbf{v_o}$ = 8.5 m/s , but no initial angular velocity. The kinetic frictional force f_k causes both a linear *deceleration* and an angular *acceleration*. The kinetic frictional coefficient between the ball and the floor is μ_k =.1 . When the ball's linear speed has decreased enough and the ball's angular velocity has increased enough, there will come a moment when the ball's contact point with the floor is no longer skidding *on* the floor! At that critical moment the frictional force vanishes! After this critical moment the velocities $\mathbf{v}_{crit}$ and $\boldsymbol{\omega}_{crit}$ are constant.

a) How long does the ball slide?

b) How far does the ball slide?

c) What is the linear speed when smooth rolling begins?

d) Make a careful graph of **v** and R**ω** versus time from the beginning until the ball is no longer skidding. Since these quantities have the same dimension you may plot them on the *same* graph.

ROLLING a Spool on the Floor (a "YoYo" problem)

A spool of string of inner radius R_1 = 3cm, outer radius R_2 = 5cm, and mass M =.2kg is unwound under a constant horizontal force F = 1.4N applied to the unwinding thread as shown. Assuming that the spool rolls *without slipping on the floor* and its center accelerates at **a** = 8m/s^2 - we wish to learn about the other features of the system. [**Warning:** this is *not* some simple disk or any other simple object! We *don't know* the Moment of Inertia! You must work ***backwards*** from the universal equations of motion …]

Please compute *from the* ***equations of motion*** and the *given numbers:*

(a) what the frictional force from the floor in *direction* and *magnitude* must be?
(b) what its *center of mass* moment of inertia must be?
(c) what its moment of inertia about the point of rolling contact must be ?