Physics 180

Problem Set # 4: **Due: noon, October 9th**

"Nature and nature's laws lay hid in night.
God said:"Let Newton be." And all was light."
-Alexander Pope (1688-1744)

1. Vidhi is watching a train wheel as it rolls along a track. Such a wheel consists of an inner rim (which makes contact with the track) with radius 0.30 *m* and a flange with radius 0.35 *m*. If the wheel rolls without slipping with a translational (axle) speed of 100 *km/hr*, what is the highest speed relative to the track attained by any point on the wheel? What is its angular position on the wheel? What is the angular position of a point (or points) on the flange whose velocity vector relative to the ground makes an angle of $\pi/4$ relative to the forward horizontal direction?

2. i) A block is in contact with a frictionless inclined plane of angle θ. Franco causes the inclined plane to accelerate at a_0 in a horizontal direction What is the acceleration of the block relative to the inclined plane in terms of g, a_0 and θ?
   ii) A block sits on top of an inclined plane that makes an angle of θ relative to the horizontal. At $\theta = \pi/7$ the block slips, moving 0.30 *m* down the plane in 1.1 *s*. Determine the coefficient of kinetic and static friction. For what angle, θ, should the block slide down the plane at constant velocity if given an initial push?

3. Catherine, a 55 *kg* firefighter working for Temagami station, slides down a pole while subjected to a constant frictional force of 250 *N*. A mass-less platform is supported by a spring to cushion the fall. The spring constant is 4 *kN/m* and the frictional force acts during the entire descent. Catherine falls 4.0 m down the pole before hitting the spring.
   i) What is Catherine's speed before she collides with the platform?
   ii) What is the maximum compression of the spring?
   iii) If the one spring is replaced by two springs connected in series, one with spring constant 4 *kN/m* and the other with spring constant 6 *kN/m* what would the maximum compression be?

4. Charlie takes a mass on a spring to a displacement of 0.1 *m* from its equilibrium position where he gives it an impulse so that it immediately has a velocity of 0.35 *m/s* (*i.e.*, moving away from the equilibrium position). After he gives the mass an impulse and notes that the first time its velocity is -0.2 *m/s*, it is displaced 0.17 *m* from its equilibrium point. Where is the mass located and what is its velocity 1 *s* after the impulse? Note: all these displacements, velocities have signs!

Practice problems:
Ch. 5: 9,13,19,21,26,33,38,44,49,53,61,68
Ch. 15: 2,7,12,22,35,40,42