PHY5210 **Problem Set #1** **due 21 January 2015**

1. **(10 points):** A uniform cylinder of radius R and mass M rests on a horizontal plank. The plank slides horizontally with acceleration A. If the cylinder rolls without slipping, what is its acceleration relative to the plank and the ground?
2. **(10 points):** Do the same calculations as in problem 9.3(a) but for the tidal force at the point Q in Figure 9.4. In this case write $\hat{\mathbf{d}}/d^2 = \mathbf{d}/d^3$ and use the binomial approximation in the form $(1+\epsilon)^{-3} \approx 1 - 3\epsilon$.
3. **(5 points):** What are the directions of the centrifugal and Coriolis forces on a person moving (a) south near the North Pole, (b) east on the equator, and (c) south across the equator.
4. **(15 points):** A pendulum is rigidly fixed to an axle held by two supports so that it can swing only in a plane perpendicular to the axle. The pendulum consists of a mass M attached to a massless rod of length ℓ. The supports are mounted on a platform which rotates with angular velocity Ω. Find the pendulum's stable equilibrium position and frequency for small amplitude oscillations when Ω is constant.
5. **(10 points):** We consider the effect of the Coriolis force on railroads in the northern hemisphere. (You can verify that the effects are reversed in the southern hemisphere.) Determine the direction (parallel to the surface) of the Coriolis force on a train running (a) east, and (b) west. Only the direction is necessary, not a calculation of the magnitude. In each case, indicate which set of wheels (right or left) push on the rail, and which rail, north or south, pushes back on the train. We consider the standard rail wheel design where a flange on the inside of the wheel keeps the train on the rail. Request explanation if this is not a familiar concept. (c) Comment on how this result might effect the maintenance of track and wheels.