Physics 262: Problem Set #7

These problems are due by the end of the day on Friday, Feb. 20 in the graders' box.
NOTE: For each problem, your solution should begin with a brief statement of the problem, i.e. a description of the setup, including a list of the inputs and the goal.

1. BTM 8.4.6 p. 222 and BTM 8.4.8 p. 223
2. There will be a worksheet to do and hand in from the Wednesday session.
3. Morin 9.9 (Striking a rectangle) p. 417
4. Morin 9.13 (Rolling in a cone) p. 417
5. Morin 9.34 (Moments for a cube) p. 422
6. Morin 9.37 (Sphere and points) p. 423
7. Morin 9.38 (Striking a triangle) p. 423
8. Morin 9.45 (Stick on a ring) p. 425
9. (K+K 7.9) This problem involves investigating the effect of the angular momentum of a bicycle's wheels. Assume the CM of the bike and rider system is height $2L$ above the ground (when untilted), where L is the radius of each wheel (both of which have mass m). Assume the wheels arehoops, with all their mass in the rim. The bicycle moves at velocity v in a circular path of radius R. Find the (tangent of the) angle ϕ at which the bicycle must tilt (here $\phi = 0$ means perfectly vertical). Take the system of rider plus bicycle to have total mass M.
10. (K+K 7.10) Latitude can be measured with a gyro by mounting the gyro with its axle horizontal and lying along the east-west axis.
    (a) Show that the gyro can remain stationary when its spin axis is parallel to the polar axis (and is therefore at the latitude angle λ with respect to the local horizontal).
    (b) If the gyro is release with the spin axis at a small angle to the polar axis, show that the gyro spin axis will oscillate about the polar axis with $\omega_{osc} = \sqrt{I_1 \omega_s \Omega / I_2}$ where I_1 is the moment of inertia about the spin axis, and I_2 is the moment through the horizontal axis. Ω is the Earth's spin rate (2π per day). What is the value of ω_{osc} for a thin disk gyro rotating at ω_s =40000 rpm?
11. (BONUS) Morin 9.54 (Rolling wheel and axle) p. 427