Physics 106b – Problem Set 9 – Due Jan 21, 2005

Version 1

January 14, 2005

These problems cover the material on rotations and rotating coordinate systems in Hand and Finch Chapter 7 and Section 5.1 of the lecture notes. Please continue to write down roughly how much time you are spending on each problem.

1. Hand and Finch 7.5. "effect of magnetic field can be made to vanish" means "$\dot{\vec{\sigma}}$ vanishes" and "find the equation of motion" means "calculate $\dot{\vec{\sigma}}$." You don't need to know how to calculate torques in rotating frames; you only need to know how to transform vectors from a nonrotating frame to a rotating frame. Be sure you only apply $\dot{\vec{\sigma}} = g' \left(\vec{\sigma} \times \vec{B} \right)$ in a frame in which you know it holds true.

2. Hand and Finch 7.13

3. Consider a frictionless turntable rotating with angular velocity $\vec{\omega}(t) = \omega(t)\,\hat{z}$. First, let ω be constant. Deposit on the turntable a particle such that it is at rest relative to a nonrotating frame. What is the shape of the particle's trajectory in the turntable frame? How do the centrifugal and coriolis forces contribute to this? Next, let there be angular acceleration $\dot{\vec{\omega}}(t) = \dot{\omega}\,\hat{z}$ where $\dot{\omega}$ is constant. Now what is the shape of the particle's trajectory in the rotating frame? Explain how the new Euler force and the changed centrifugal and coriolis forces determine the particle's trajectory.

4. Hand and Finch 7.15

5. Thornton 10.6: A bucket of water is set spinning about its axis of symmetry. The bucket is in a uniform gravitational field that points downard along the same direction as the bucket symmetry axis. Assume that somehow the water is imparted the same angular velocity as the bucket – e.g., by viscosity. Determine the shape of the surface of the water in the bucket by both force and energy methods.