PHZ 3113, Problem Set No. 8. Due Fri., March. 6, 2009.

W&A 2.3.3 (do the sketch *by hand*!)

W&A 2.5.3

W&A 2.5.7 (note misprint: $f(\mathbf{r})$ should be $f(r)$.)

Problem 4

Use the results from Problem W&A 2.5.6 to find v_r, v_θ, v_ϕ, a_r, a_θ, and a_ϕ for a particle that moves with constant angular velocity ω on a circle of constant radius R in the xy plane.

Discuss your results in light of your knowledge of classical mechanics.

Problem 5

Under time-indpendent conditions, magnetic fields obey the two Maxwell equations,

$$\nabla \cdot \mathbf{B} = 0 \tag{1}$$

and

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} \ , \tag{2}$$

where the constant μ_0 is the magnetic permeability.

A straight cylindrical conductor of radius R carries a constant current with current density $\mathbf{J} = J\hat{k}$ in the z direction. (Current density is current per unit cross-sectional area of the conductor.) This problem thus has cylindrical symmetry and should be handled in cylindrical coordinates. The axial compoonent of $\mathbf{B}$, $B_z = 0$.

(a) Use Gauss' theorem and Eq. (1) to show that the radial component of $\mathbf{B}$, $B_\rho = 0$.

(b) Use Stokes' theorem and Eq. (2) to find the tangential component of $\mathbf{B}$, B_ϕ, as a function of ρ, both for $\rho \le R$ and $\rho > R$. Sketch $B_\phi(\rho)$.

(Hint for a and b): Remember how we used Gauss' theorem to find the field from a uniform, spherically symmetric charge or mass distribution.

(c) Given the results you obtained for $\mathbf{B}$ above, calculate $\nabla \cdot \mathbf{B}$ and $\nabla \times \mathbf{B}$ to verify the Maxwell equations, both for $\rho \le R$ and $\rho > R$.

Problem 6

Write a short resume of the most important points in those parts of Ch. 2 that I included in lectures or problems.