

# PHY 504

## Problem Set #6

due 16 October 2009

1. A particle of mass  $m$  moves in a uniform magnetic field of magnitude  $B$ .
  - (a) Write down a Lagrangian describing this system and the resulting equations of motion.
  - (b) Use Noether's theorem to obtain expressions for the conserved energy, momentum, and angular momentum in the plane perpendicular to the magnetic field. Write these in polar coordinates.
  - (c) Explain how to solve for the particle's motion. Obtain the solution for a circular orbit of energy  $E$  and angular momentum  $l$ .

2. For the inverse-square potential

$$V(r) = -\frac{k}{r^2}$$

- (a) Calculate the differential cross section  $\sigma(\Theta)$ .
  - (b) Calculate the capture cross section – this is defined to be the cross-sectional area of an incoming beam of particles of energy  $E$ , which gets captured rather than scattered by the potential.
3. Exercise 3.30.
4. Derivation 4.2. Show that the product of two orthogonal matrices is orthogonal.
5. Derivation 4.10. Exponentiate the matrix

$$\begin{pmatrix} 0 & 0 & \theta \\ 0 & 0 & 0 \\ -\theta & 0 & 0 \end{pmatrix}$$