Phys 503 Classical Mechanics I **Fall 2013**

Homework Assignment #1 **Due Thursday, September 5**
(90 points) **(at lecture)**

1.1 (10 points) Goldstein 1.8

1.2 (10 points) Goldstein 1.9. This problem is a good example of the pernicious effects of the SI police. (You're worried about the NSA? Spend a little time worrying about the SI police.) Goaded by the SI police, the revisors of the 3rd Edition made the Lagrangian in the text [Eq. (1.63)] consistent with SI, but neglected to modify the gauge transformation in this problem, which is the gauge transformation for cgs Gaussian. You should do this problem with the Lagrangian and gauge transformation for SI or with the Lagrangian for cgs Gaussian, but mixing them is a bad idea.

SI	**cgs Gaussian**
$L = \frac{1}{2}mv^2 - q\phi + q\mathbf{A}\cdot\mathbf{v}$	$L = \frac{1}{2}mv^2 - q\phi + \frac{q}{c}\mathbf{A}\cdot\mathbf{v}$
$\mathbf{A} \to \mathbf{A}' = \mathbf{A} + \nabla\psi(\mathbf{r},t)$	$\mathbf{A} \to \mathbf{A}' = \mathbf{A} + \nabla\psi(\mathbf{r},t)$
$\phi \to \phi' = \phi - \frac{\partial\psi}{\partial t}$	$\phi \to \phi' = \phi - \frac{1}{c}\frac{\partial\psi}{\partial t}$

1.3 (10 points) **Summation convention and antisymmetric symbol.** In a right-handed Cartesian coördinate system, the curl of a vector can be written as

$$\nabla \times \mathbf{A} = \mathbf{e}_j \epsilon_{jkl} A_{l,k}.$$

Using the summation convention and the antisymmetric symbol, show that

$$\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2\mathbf{A},$$

where the vector Laplacian is defined as

$$\nabla^2\mathbf{A} = \mathbf{e}_j A_{j,kk}.$$

1.4 (10 points) Goldstein 1.19

1.5 (10 points) Challenge problem (a)

1.6 (10 points) Goldstein 2.14

1.7 (10 points) Goldstein 2.16 (The point transformation should be defined by $s = e^{\gamma t/2}q$, instead of $s = e^{\gamma t}q$.)

1.8 (10 points) Goldstein 2.18

1.9 (10 points) Challenge problem (b)