

Problem Set 2  
Electrodynamics  
Spring, '05  
**Due: April 22, 2005**

**Problem 1:** Jackson 6.15

**Problem 2:** Jackson 6.17

**Problem 3:** Jackson 6.20

**Qualifying Exam Problems:**

*Do not use Mathematica on these problems.*

Mechanics, Question 2 – Spring, '05

A classical point particle of mass  $m$  and charge  $q$  moves with a non-relativistic velocity  $\mathbf{v}$  in an electromagnetic field specified by the vector and scalar potentials  $\mathbf{A}$  and  $\Phi$ . Show that choosing its Lagrangian to be

$$L = \frac{1}{2}mv^2 + \frac{q}{c}\mathbf{v}\cdot\mathbf{A} - q\Phi$$

leads to the correct expression for the Lorentz force. (Note for our class: This Lagrangian is written in Gaussian units. In MKS units, the  $c$  would be absent. But, you have to be prepared for any kind of units on the exam. Work this problem in Gaussian units.)

*Hint:* You may, if you like, make use of the relation

$$\nabla(\mathbf{a}\cdot\mathbf{b}) = (\mathbf{a}\cdot\nabla)\mathbf{b} + (\mathbf{b}\cdot\nabla)\mathbf{a} + \mathbf{a}\times(\nabla\times\mathbf{b}) + \mathbf{b}\times(\nabla\times\mathbf{a}).$$

Electricity and Magnetism, Question 1 – Spring, '05

Two concentric spherical surfaces have radii  $R_a$  and  $R_b$ , with  $R_a < R_b$ . These surfaces enclose a vacuum. The electric potential on the inner surface is  $V_a P_3(\cos\theta)$  and the electric potential on the outer surface is  $V_b P_5(\cos\theta)$ , where  $V_a$  and  $V_b$  are constants. Find the potential at all points between the two spherical surfaces.

*Hint:* The radial part of the Laplacian is given by:

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \frac{\partial}{\partial r} \right).$$

