

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 Φ . 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:

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

