Physics 7740, Fall 2008

Problem Set 1. Due Monday, September 8.

1. A plane triangle has sides a, b, c, and angles α (opposite side a), β (opposite side b), and γ (opposite c). Represent the magnitudes and directions of the sides by vectors $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, and use the vector cross-product to show that the Law of Sines is obeyed for a plane triangle:

$$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$$

Hint: $\mathbf{A}$, $\mathbf{B}$, and $\mathbf{C}$ are not independent.

2. Consider now a spherical triangle, defined by the three vectors $\mathbf{R_A}$, $\mathbf{R_B}$, $\mathbf{R_C}$, which are sphere radii extending from the sphere center O to the respective vertices A, B, C of the spherical triangle. The triangle's side a (which is the great-circle arc from B to C) will satisfy a relation connecting $\sin a$ to a vector cross-product. The angle α (at vertex A) will be the dihedral angle between the plane OAB and the plane OAC, and it is possible to relate this dihedral angle to an appropriate vector product. Use these vector relationships (and perhaps experience obtained from your solution to Problem 1) to derive the Law of Sines for a spherical triangle:

$$\frac{\sin\alpha}{\sin a} = \frac{\sin\beta}{\sin b} = \frac{\sin\gamma}{\sin c}$$

3. Exercise 1.7.6.

4. Exercise 1.8.9. You may need to consult 1.8.7 and 1.8.8 for definitions.

5. Exercise 1.9.12.

6. Exercise 1.11.9. The relevant Maxwell equation is

$$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial \mathbf{t}} + \mathbf{J}$$

As implied by the *Hint*, the assumption of steady currents allows us to set $\partial\mathbf{D}/\partial\mathbf{t} = \mathbf{0}$. The hint also emphasizes the importance of the fact that the currents are *localized*.