PHYS 832 Problem Set #1 Due: January 29, 2015

1. An insulated, spherical conducting shell of radius a is in a uniform electric field E_0. If the sphere is cut into two hemispheres by a plane perpendicular to the field, find the force required to prevent the hemispheres from separating
    a. If the shell is uncharged;
    b. If the total charge on the shell is Q.

2. Show that Maxwell's wave equation for EM waves (light) is invariant under Lorentz transformation by explicitly transforming the wave equation to the primed coordinates in a different reference frame S'.

3. An infinitely long straight wire of negligible cross-sectional area is at rest and has a uniform linear charge density of q_0 in the inertial frame S'. The frame S' (and the wire) move with a velocity **v** parallel to the direction of the wire with respect to the laboratory frame S.

    a. Write down the electric and magnetic fields in cylindrical coordinates in the rest frame of the wire. Using the Lorentz transformation properties of the fields, find the components of the electric and magnetic fields in the laboratory reference frame.
    b. What are the charge and current densities associated with the wire in its rest frame? In the laboratory?
    c. From the laboratory charge and current densities, calculate directly the electric and magnetic fields in the laboratory. Compare with the results of part a.