Physics 2020 Assignment 4

1. Calculate the potential energy, per ion, for an infinite one dimensional ionic crystal, that is, a row of equally spaced charges of magnitude e and alternating sign. Hint: The power series expansion of ln (1+x) may be of use.

2. At the beginning of the century the idea that the rest mass of the electron might have a purely electrical origin was very attractive, especially when the equivalence of energy and mass was revealed by special relativity. Imagine the electron as a ball of charge, of constant volume density out to some maximum radius r_o. Using the Set the potential energy of this system equal to mc^2 and see what you get for r_o. One defect of the model is rather obvious: Nothing is provided to hold the charge together!

3. Consider three plane charged sheets, A, B and C. The sheets are parallel with B below A and C below B. On each sheet there is surface charge of uniform density: -4 esu/cm^2 on A, 7 esu/cm^2 on B and -3 esu/cm^2 on C. The density given includes charge on both sides of the sheet. What is the magnitude of the electrical force on each sheet in dynes/cm^2?

4. A sphere of radius r has a charge q distributed uniformly over its surface. How large a sphere contains 90% of the energy stored in the electrostatic field of this charge distribution?

5. Concentric spherical shells of radius a and b, with b > a carry charge Q and –Q, respectively, each charge uniformly distributed. Find the energy stored in the electric field of this system.