Phyx 135-2, Fall 2016, Quiz #2 **Name** ____

Section 02 (1 pm) **Show all work for full credit**

1) A hydrogen atom can be thought of as a uniform ball of positive charge (the proton) surrounded by a uniform spherical shell of negative charge (the electron). Assume that the proton has a radius of 10^{-15} m and that the electron shell has a radius of 5×10^{-11} m.

Useful facts: $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2 / N\ m^2$, $e = 1.6 \times 10^{-19}$ C

a) (5 points) What is the charge density of the proton?

Solution: The charge on the proton is $e = +1.6 \times 10^{-19}$ C. Therefore $\rho = e$ / volume $= e/(^4/_3\pi r^3) = (1.6 \times 10^{-19}) / (1.333)(3.14159)(10^{-15})^3 = 3.8 \times 10^{25}\ C/m^3$.

b) (15 points) What is the electric field at a radius of 5×10^{-16} m from the center of the proton?

Solution: This radius places the field well within the proton itself. From Gauss' Law, and using spherical symmetry, we know: (electric field) X (surface area of sphere) = (charge enclosed) / ε_0.

So, $E(4\pi r^2) = \rho V / \varepsilon_0 = \rho(4\pi/3)r^3 / \varepsilon_0$, or $E = \rho r/3\varepsilon_0$. Inserting numbers,

$E = (3.8 \times 10^{25}\ C/m^3)(5 \times 10^{-16}\ m) / (3)(8.85 \times 10^{-12}\ C^2 / N\ m^2) = 7.2 \times 10^{20}$ N/C.