

NAME \_\_\_\_\_

Physics 412: Introduction to Electrodynamics

Test 1

Friday, 23 October, 2009

Do 3 out of the 4 following questions. Please mark clearly the 3 questions you wish to have marked.

Problem 1:

The *plum pudding* atomic model proposed by J. J. Thomson in the early 1900s imagined that the positive charges ( $Ze$ ) were spread uniformly over a spherical volume and that the electrons (charge  $-e$ , mass  $m_e$ ) were point particles free to move in the interior of the sphere. Ignore the interaction between electrons.

- a. Find the force acting on an electron at radius  $r < R$ , where  $R$  is the radius of the positively charged sphere. Consider only the electric field produced by the positive charges.
- b. If the electron is allowed only to move radially, it will perform harmonic motion passing through the center of the sphere. Find the frequency for this motion.

Problem 2:

a. Of the following fields, which is(are) conservative?

i.  $\vec{E} = c(x - z)^2(\hat{x} - \hat{z})$

ii.  $\vec{E} = 2xyz\hat{x} + xz^2\hat{y} + x^2y\hat{z}$

b. Find the electric potential(s) for the conservative field(s) by calculating the line integral starting from origin.

c. Find the charge distribution(s) which produce the conservative field(s).

Problem 3:

An infinite charged sheet has uniform surface charge density  $\sigma$ . A circular hole of radius  $R$  is made in the charged sheet. Find the electric field  $\vec{E}$  on the axis of the circular hole.

Problem 4:

A charged hemispherical shell, surface charge density  $\sigma$ , with radius  $R$  is shown below. Find the electric field at the origin.