Print your name clearly:____

Signature:____

"I agree to abide by the Duke Community Standard and will neither give nor receive aid during this quiz."

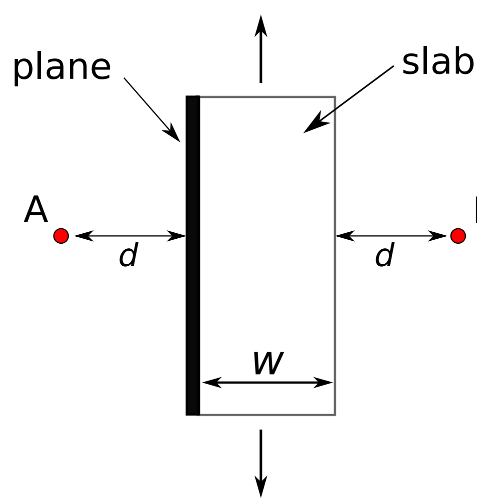
Physics 162: Quiz 2

Professor Greenside
Wednesday, January 28, 2015

This 30-minute quiz is closed book and nothing is allowed on your desk except items to write with. Please write all answers on the blank pages handed out in class. Please also write your name and problem number on each page, order the pages in increasing order of problem number, and staple all of your pages together at the end of the quiz.

Unless stated otherwise, you need to justify your reasoning, e.g., with brief phrases and drawings; a correct answer without some explanation will get zero credit. If your answers are not easily readable and understandable by the grader, you will lose credit and possibly get no credit.

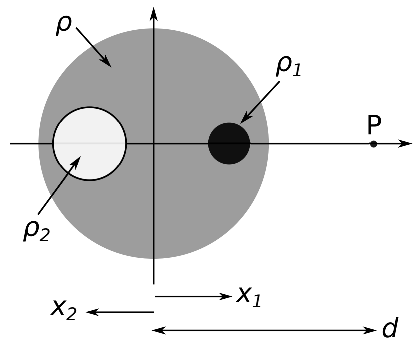
1. **(8 points)** An infinite non-conducting plane with constant surface charge density $\sigma > 0$ is glued to the left side of an infinite non-conducting slab of width w and of constant volume charge density $\rho > 0$, as shown in cross-section in this figure (so the plane and slab are perpendicular to the plane of this page and continue forever in the directions of the vertical arrows):



In terms of the given parameters d, W, σ, and ρ, give expressions for the electric field vectors $\mathbf{E}_A$ and $\mathbf{E}_B$ at the points A and B in this figure, which each lie a distance d from the nearest surface of this object.

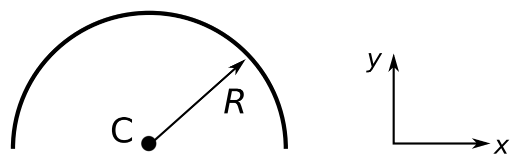
Note: recall that the electric field magnitude E at any point in space due to an infinite plane with constant surface charge density σ is given $E = 2\pi K\sigma$ where K is Coulomb's constant.

2. **(8 points)** A non-conducting sphere of radius R and constant volume charge density ρ contains a smaller non-conducting sphere of radius R_1 and uniform charge density ρ_1 with center at coordinate $x = x_1$, and a second smaller non-conducting sphere of radius R_2, uniform charge density ρ_2, and center at $x = x_2 < 0$ as shown in this figure:



In terms of the given parameters, obtain and give an expression for the electric field vector $\mathbf{E}(x)$ at the point P that lies at coordinate $x = d > 0$ on the line passing through the centers of the three spheres.

3. (a) **(8 points)** A thin non-conducting rod with a constant (uniform) negative linear charge density $\lambda < 0$ is bent into a half circle of radius R as shown here:

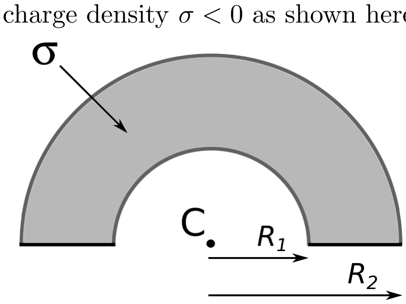


Show that the magnitude E of the electric field vector $\mathbf{E}$ at the center C of the half circle is

$$E = \frac{2K\lambda}{R}, \tag{1}$$

and give the direction of $\mathbf{E}$.

(b) **(8 points)** Consider a non-conducting half of an annulus of inner radius R_1, outer radius R_2, and constant negative surface charge density $\sigma < 0$ as shown here:



Using your result in 3(a) above, find a concise expression for the electric field vector $\mathbf{E}$ at the center C of the half annulus, and discuss briefly what your expression predicts for the electric field at the center of a half-disk, which is the limit $R_1 \to 0$ of this annulus.

Note: any integral in your expression should be explicitly evaluated so that your final answer has no integrals.