Exam Potential Problems

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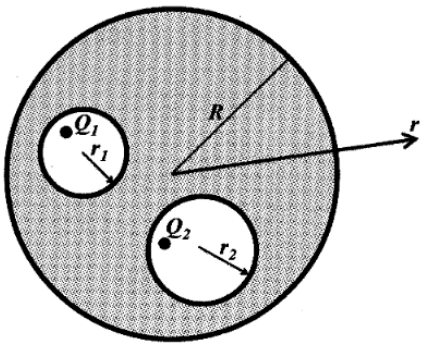
1 Potential Midterm Potentials

1.1 Conductors

An uncharged solid conducting sphere of radius R, centered at the origin, contains two spherical cavities or radii r_1 and r_2, respectively. Point charge Q_1 is then placed within the cavity of radius r_1, and point charge Q_2 is then placed within the cavity of radius r_2, as shown below. Determine the resulting electric field vector for $r > R$, where r is the distance from the origin.

(*Source: Birgeneau Fall 2015 Midterm 2, Problem 2*)



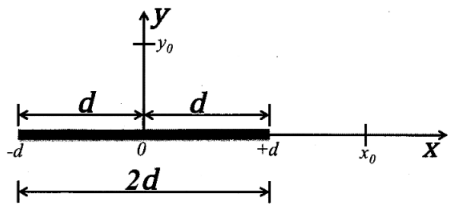
1.2 Rods

Consider a thin rod of length $2d$ centered on the x-axis as shown. The rod has a non-uniform linear charge distribution $\lambda = ax$. Determine the potential V for

(a) a point along the y-axis at a distance y_0 from the origin

(b) points along the x-axis outside the rod, at a distance x_0 from the origin

(*Source: Birgeneau Fall 2015 Midterm 2, Problem 3*)



1.3 Connected Conductors

Two conducting globes (spherical shells) with radii r_1 and r_2, with $r_2 = 2r_1$, are joined by a long thin wire. +ve charge is steadily added to the system until a faint glow is seen around one of the spheres, a consequence of ionisation of the air nearby. Which is it? (no credit for simply giving the answer without proof).

(*Source: Bloxham Summer 2015 Midterm 2, Problem 2*)

1.4 The Slab

The figure shows an infinite slab of charge that has a width, d, and within which the charge density, $\rho(x) = \rho_0 cos\left(\frac{n\pi x}{d}\right)$.

(a) The electric field is zero for $x \leq 0$ **and** $x \geq d$. What, then, are the possible values of n?

(b) Take $V(0) = 0$. Under the conditions in part a, what is the electric potential, $V(x)$, inside the slab (for $0 \leq x \leq d$)? Express it in terms of n, π, ρ_0, ϵ_0, d, and x.

(*Source: Speliotopoulos Spring 2014 Midterm 2, Problem 2*)