Physics 9C-C Midterm Exam #1 (Winter of 2021)

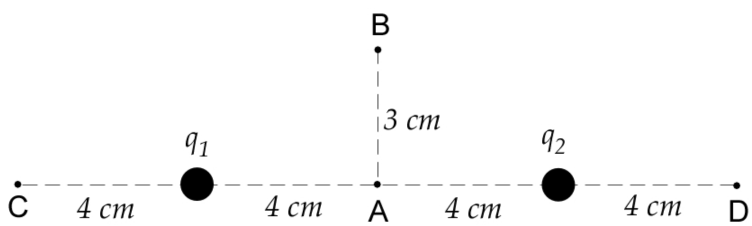
1. ***Point charges***

In the figure below, a point charge q_1 = + 1 nC and another charge q_2 = - 1 nC are placed on the x-axis and separated by 8 cm. Let Point A in the middle be the origin. A target charge Q = + 2 nC is placed on the y-axis at y = + 3 cm (Point B). $\varepsilon_0 = 8.85\times10^{-12}\ C^2/N\cdot m^2$.

(a) (**10 points**) Find the x- and y-components of the net Coulomb force on Q (at Point B) exerted by q_1 and q_2.

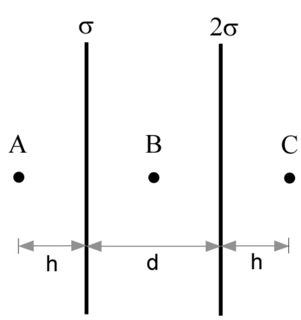
(b) (**8 points**) Find the electric potential difference, $V_A - V_B$, produced by the electric fields of q_1 and q_2.

(c) (**8 points**) When Q is moved from Point C to Point D, what is the potential energy change for Q, i.e., $U_C(Q) - U_D(Q)$, in the electric field produced by q_1 and q_2?



2. ***Effect of a combination of large charge sheets***

In the following figure, two infinitely large charge sheets, parallel to each other, are separated by a distance *d*. One has a surface charge density σ and the other has a surface charge density twice as large. Let the x-axis be perpendicular to the sheets. Point B is in the middle between the two sheets.



(a) (**12 points**) Find the electric fields at A, B, and C.

(b) (**15 points**) Find the electric potential difference between A and C.

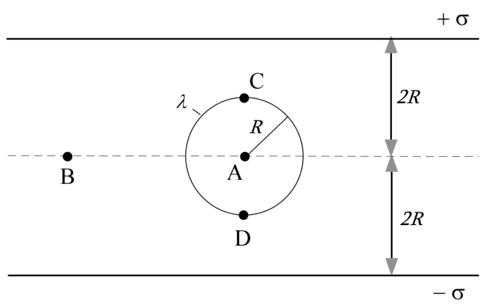
3. ***Combination of differently shaped charge distributions:***

In the figure below, a long insulating cylindrical shell with radius *R* and negligible thickness carries a uniformly distributed charge λ per unit length. It is place between two infinitely large insulating charge sheets. The charge sheets and the cylindrical axis of the shell are parallel.

(a) (**10 points**) Find the electric field at B

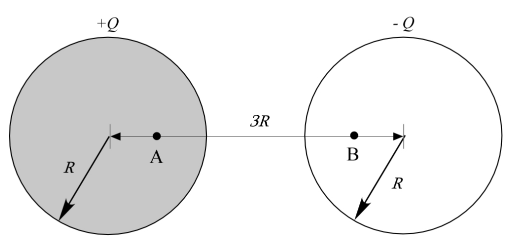
(b) (**10 points**) Find the potential difference between the center of the cylindrical shell A and Point B, i.e., V_A - V_B.

(c) (**5 points**) Find the electric potential difference between Point C and D, i.e., V_C - V_D.



4. ***Effect of two spherically symmetric charge distributions***

In the figure below, an insulating solid sphere with radius R is uniformly charged throughout its volume with + Q. An insulating spherical shell with radius R and negligible thickness is uniformly charged with - Q. The distance between centers of the two charge distributions is 3R. Point A is half way between the center and the surface of the solid sphere. Point B is half way between the center and the surface of the thin shell.



(a) (**8 points**) Find the total electric field at A;

(b) (**6 points**) Find the total electric field at B;

(c) (**10 points**) Find the electric potential difference, $V_A - V_B$., produced by just the charge on the solid sphere;

(d) (**8 points**) Find the electric potential difference, $V_A - V_B$., produced by just the charge on the thin spherical shell.