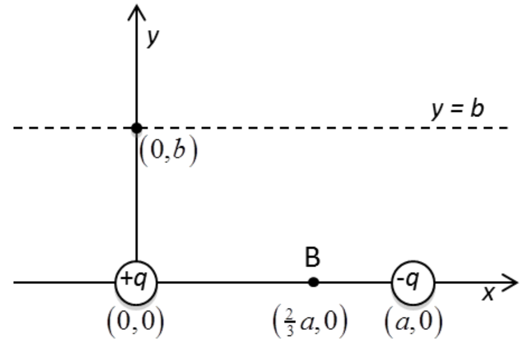
Name ______________________________________ **Student ID Number** _____________

last *first*

The first two questions pertain to the situation described below.

Two point charges are fixed in place as shown at the right. The magnitude of each charge is equal to q = 5 μC. Both charges lie on the x-axis: one at the origin, and one at $x = a$ (= 5 cm). The signs of the charges are indicated in the drawing. The questions pertain to the electric field that these two charges produce.

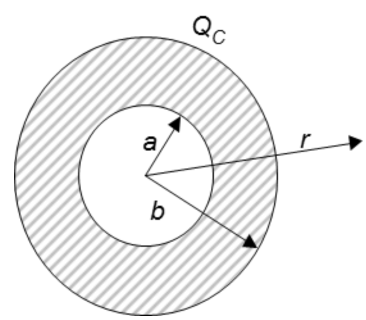


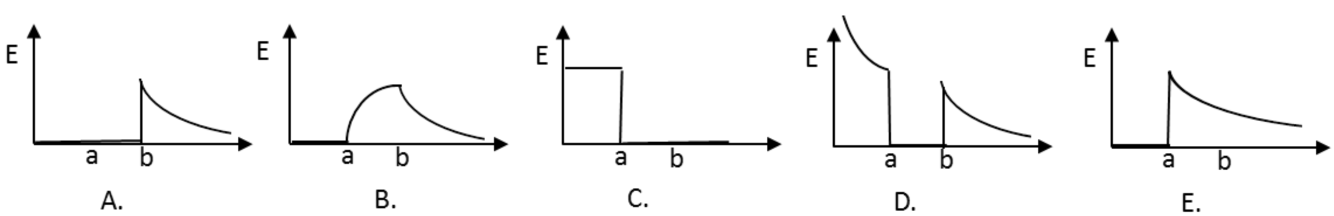
1. (5 pts.) What is the magnitude of the electric field at point **B**, located at $(x,y) = (\frac{2}{3}a\ \mathbf{,\ 0})$?
   A. -1.21×10^{8} N/C
   B. 2.02×10^{8} N/C
   C. 1.21×10^{8} N/C
   D. 4.05×10^{6} N/C
   E. 1.01×10^{3} N/C

2. (3 pts) At what point on the line dashed line $y = b$ (= 4 cm) is the ***y* component** of the electric field zero? That is, for what value of x is $E_y = 0$?
   A. 2.5 cm
   B. -2.5 cm
   C. Nowhere on the $y = b$ line.

.

3. (5 pts) A conducting spherical shell of inner radius a and outer radius b has a net charge Q = +6 μC. Which of the plots below best describes the radial component of the electric field as a function of distance from the center of symmetry for the above system?





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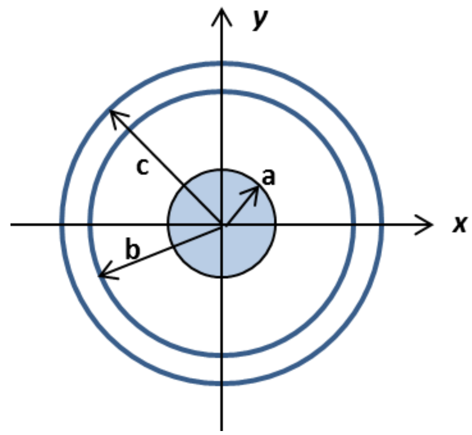
The next two questions are related.

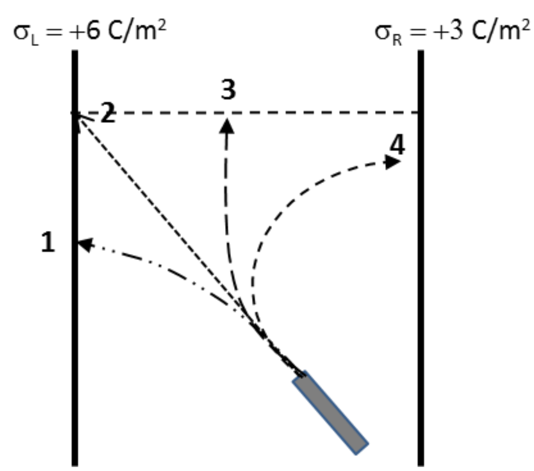


An insulating cylinder, concentric with the *z* axis, has a radius **a** and a linear charge density λ. It is surrounded by a concentric, cylindrical conducting shell with inner radius **b**, outer radius **c** and linear charge density $-\lambda$. The cylinders will be treated as infinitely long.

4. (5 pts) Find the **surface** charge density on the surface of the conducting shell at ***r* = *b*.**
   A. $+\lambda/(2\pi b)$
   B. $+2\lambda\pi b$
   C. 0
   D. $-\lambda/(2\pi b)$
   E. $-2\lambda\pi b$

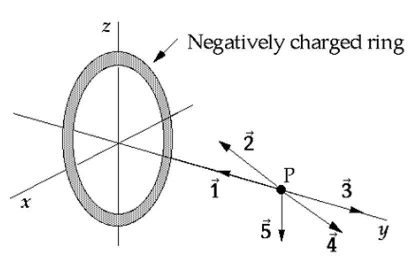
5. (3 pts) If you placed a positively charged particle on the x axis between r = b and r = c, which way would it move?
   A. +x direction
   B. –x direction
   C. It would not move

6. (5 pts) In the figure on the right, two infinitely long charged planes have the indicated uniform charge densities. An electron "gun" emits electrons at the trajectory shown. What is the best choice for the path an electron might take in this configuration (ignore gravity)?



   A. 1
   B. 2
   C. 3
   D. 4
   E. You need to know the initial electron velocity to choose

7. (5 pts) The point P is on the axis of a ring of charge, and all vectors shown lie in the yz plane. The negatively charged ring lies in the xz plane. The vector that correctly represents the direction of the electric field at point P is



   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

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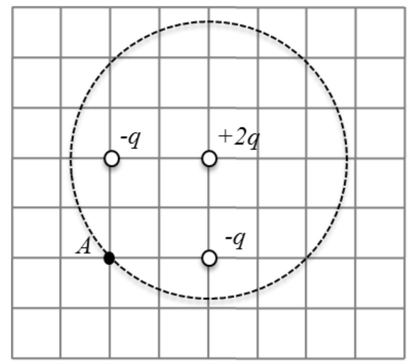
The next three questions pertain to the figures on the right.

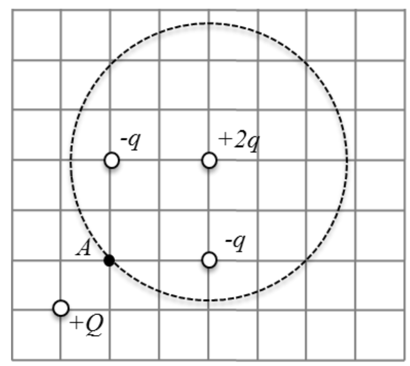
A spherical Gaussian surface (dashed line) that passes through point **A** encloses the three point charges as shown.



8. (3 pts) What is the net flux through the Gaussian surface?

   A. zero
   B. $4q/\varepsilon_0$
   C. You cannot determine it from this geometry

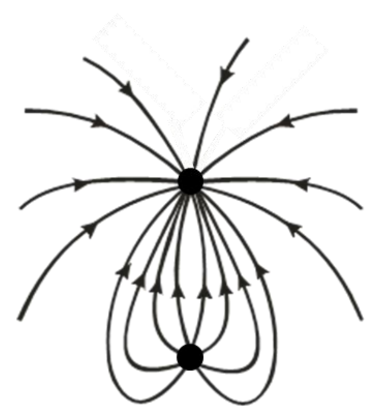
9. (3 pts) A new point charge +Q, of unknown magnitude, is added as shown in the next figure. The magnitude of the flux through the Gaussian surface



   A. increases
   B. decreases
   C. remains the same

10. (4 pts) How does the electric field at point **A** change after the new charge +Q is added? It will …

   A. change in direction only
   B. change in direction and magnitude
   C. change in magnitude only
   D. remain the same



11. (4 pts) The figure shows the field lines for two charges. What is the ratio of the **top** charge to the **bottom** charge?

   A. 1 : 2
   B. -1 : 2
   C. 2 : 1
   D. -2 : 1
   E. 2 : -1