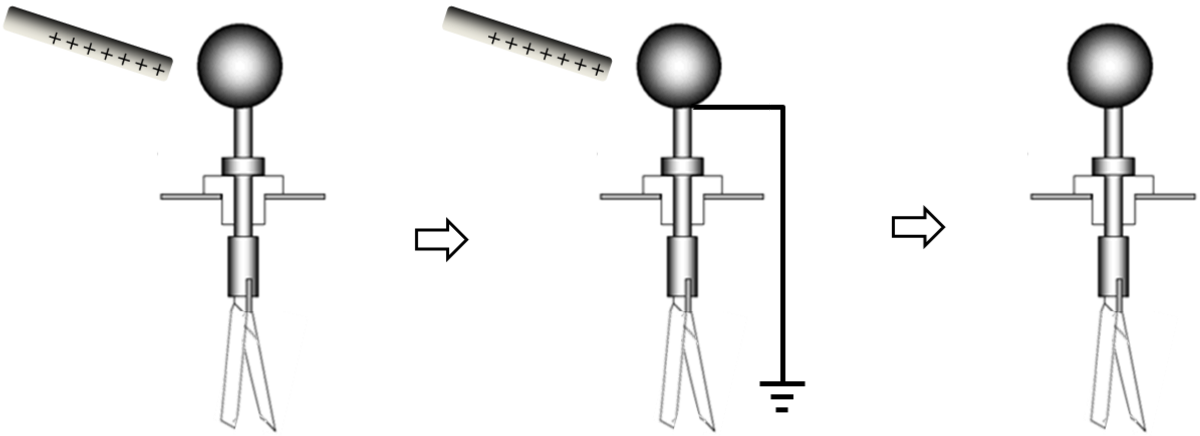
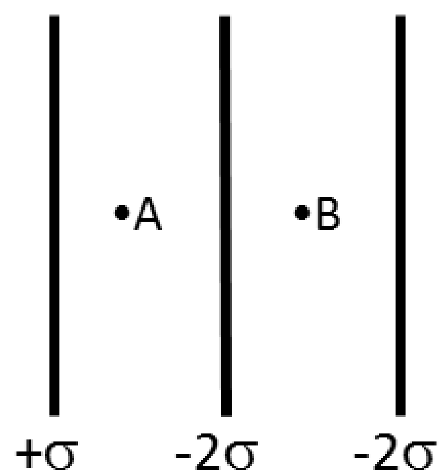
Consider an experiment on electrostatics, similar to those in your first lab session. A positively charged rod is brought near (but does not touch) an electroscope as shown. Then, the electroscope is briefly grounded.



1) Regarding the whole sequence of three steps, which statement is NOT true?

a. Negative charges will flow from the ground to the electroscope.
b. The metal leaves at the bottom of the electroscope will repel each other when the rod is moved away.
c. Positive charges will be induced on the electroscope when the rod is moved away.

Consider three parallel infinite planes, with different surface charge densities as shown.

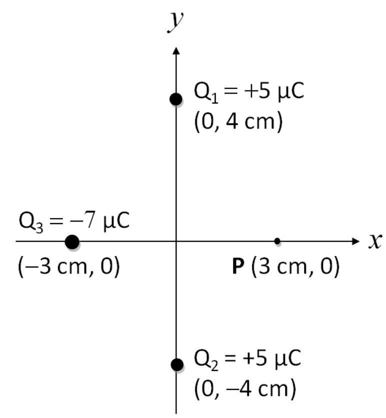


2) Find the ratio of the magnitude of the electric field at point A to the magnitude of the electric field at point B, E_A/E_B:

a. $E_A/E_B = \infty$
b. $E_A/E_B = 3/4$
c. $E_A/E_B = 1$
d. $E_A/E_B = 5$
e. $E_A/E_B = 2$

The next two questions pertain to the situation described below.

Three point charges are placed on the x-y plane, as shown.



3) What is the direction of the electric field at point **P** due to the two charges Q_1 and Q_2 only?

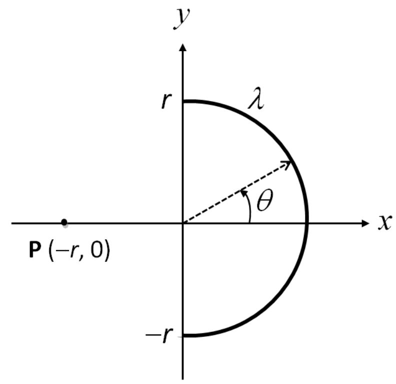
a. The electric field is zero at that point.
b. Negative x-axis
c. Positive x-axis

4) If a point charge of 1 Coulomb is placed at **P**, what is the x-component of the net electric force exerted on it by all the other three charges?

a. $F_x = +1.3 \times 10^7$ N
b. $F_x = +4.1 \times 10^6$ N
c. $F_x = -1.3 \times 10^7$ N
d. $F_x = +3.0 \times 10^4$ N
e. $F_x = -4.1 \times 10^6$ N

The next three questions pertain to the situation described below.

A uniformly charged semi-circular line with linear charge density λ is placed in the x-y plane as shown at right. Its radius is r and its total charge Q = +15 μC.



5) If r = 5 cm, what is λ?

a. λ = 150 μC/m
b. λ = 95 μC/m
c. λ = 48 μC/m

6) What is the correct expression for the x-component of the total electric field at the origin, E_x, due to this charge?

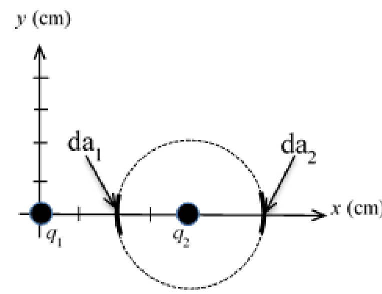
a. $E_x = -\int_{-\pi/2}^{\pi/2} \frac{k\lambda}{r} sin\theta \, d\theta$
b. $E_x = -\int_{-\pi/2}^{\pi/2} \frac{k\lambda}{r} cos\theta sin\theta \, d\theta$
c. $E_x = 0$
d. $E_x = -\int_{-\pi/2}^{\pi/2} \frac{k\lambda}{r^2} cos\theta \, d\theta$
e. $E_x = -\int_{-\pi/2}^{\pi/2} \frac{k\lambda}{r} cos\theta \, d\theta$

7) What kind of point charge should be placed at point **P**(-r, 0) in order to make the net electric field at the origin vanish?

a. There is no such charge.
b. Positive charge
c. Negative Charge

The next two questions pertain to the situation described below.

Consider a charge $q_1 = +3$ μC placed at the origin and a charge $q_2 = -6$ μC placed a distance 4 cm away along the +x-axis. A spherical Gaussian surface of radius 2 cm is positioned around q_2, as shown. Two small, equal sized patches—da_1 and da_2—are marked at different locations on the surface.



8) Compare the <u>density</u> of the electric field lines, n_1 and n_2, which pass through da_1 and da_2, respectively.

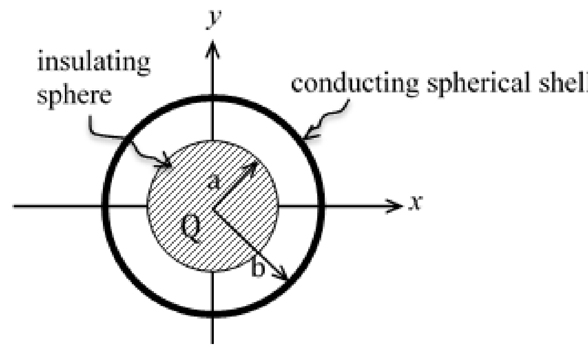
a. $n_1 < n_2$
b. $n_1 = n_2$
c. $n_1 > n_2$

9) What is the net flux that passes through the entire Gaussian surface?

a. -3.4×10^5 N-m^2/C
b. -3×10^{-6} N-m^2/C
c. -6.8×10^5 N-m^2/C
d. 6.8×10^5 N-m^2/C
e. -6 N-m^2/C

The next three questions pertain to the situation described below.

Consider an insulating sphere of radius a = 6 cm, centered around the origin, that carries a total charge of Q = +8 μC. (You may assume that the charge is distributed uniformly throughout the volume of the insulator). Concentric to the insulator is an uncharged conducting spherical shell of radius b = 10 cm, as shown.



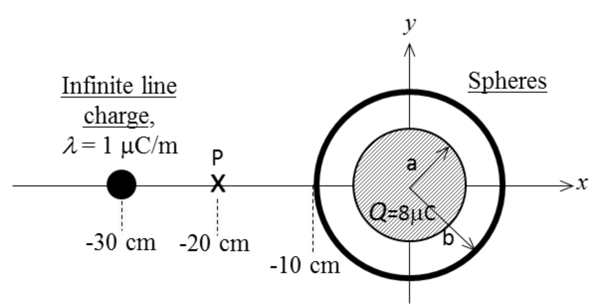
10) Find the magnitude of the electric field at a point located at (x, y) = (4 cm, 0).

a. 3 x 10^7 N/C
b. 0.72 x 10^7 N/C
c. 1.3 x 10^7 N/C
d. 2 x 10^7 N/C
e. 4.5 x 10^7 N/C

11) Find the surface charge density on the inner surface of the spherical shell at b = 10 cm.

a. 8 x 10^{-6} C/m^2
b. 0 C/m^2
c. -6.4 × 10^{-5} C/m^2

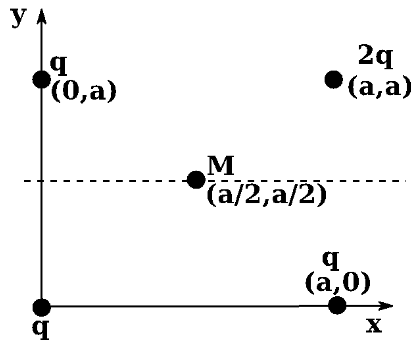
12) An infinite line charge having λ = 1 μC/m is now added parallel to the z-axis and centered at (x, y) = (–30 cm, 0), as shown. Find the electric field at the point P located at (x, y) = (–20 cm, 0).



a. -7.0 x 10^6 N/C $\hat{x}$
b. 2.0 x 10^6 N/C $\hat{x}$
c. -1.6 x 10^6 N/C $\hat{x}$
d. 7.4 x 10^6 N/C $\hat{x}$
e. 1.8 x 10^5 N/C $\hat{x}$

The next three questions pertain to the situation described below.

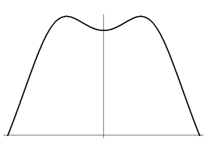
Four point charges with charge q, q, q, and $2q$ are arranged as shown in the diagram.

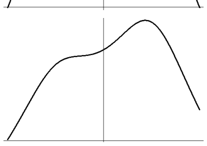


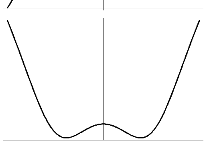
13) What is the work required to assemble this charge configuration? Assume the charges start at infinity.

a. $\frac{q^2}{4\pi\epsilon_0 a}(5)$
b. $\frac{q}{4\pi\epsilon_0 a}(3+\frac{1}{\sqrt{2}})$
c. $\frac{q^2}{4\pi\epsilon_0 a}(\frac{4}{\sqrt{3}})$
d. $\frac{q}{4\pi\epsilon_0 a}(2+\sqrt{2})$
e. $\frac{q^2}{4\pi\epsilon_0 a}(6+\frac{3}{\sqrt{2}})$

14) Which sketch below is a better representation of the electric potential along the dotted line in the figure above? Note that point M is marked in the sketches.

a. 

b. 

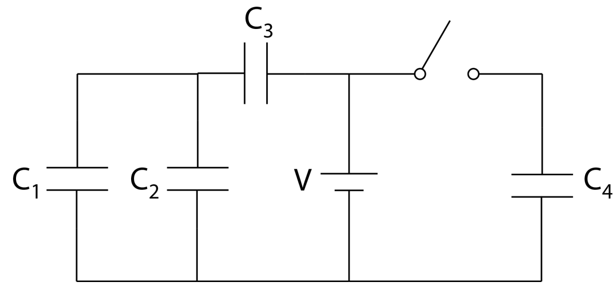
c. 

15) If a positively charged particle is placed at M, what is the best representation of the direction of the force on that particle?

a. the net force is zero
b. right
c. down and left

The next four questions pertain to the situation described below.

Four parallel plate capacitors are connected to a battery as shown in the circuit diagram. For the problems below, the switch has been closed for a long time, and the charge on capacitor C_1 is observed to be 5.83 oC. (Note 1 μC = 10^{-6} C.) C_1 = 6 μF, C_2 = 8 μF, C_3 = 12 μF, and C_4 = 10 μF.



16) Capacitors C_3 and C_4 are connected

a. series
b. neither in series nor in parallel
c. parallel

17) What is C_{1234}, the equivalent capacitance of the combination of four capacitors?

a. C_{1234} = 6.1 μF
b. C_{1234} = 36 μF
c. C_{1234} = 8 μF
d. C_{1234} = 160 μF
e. C_{1234} = 16 μF

18) What is V_3, the voltage across C_3?

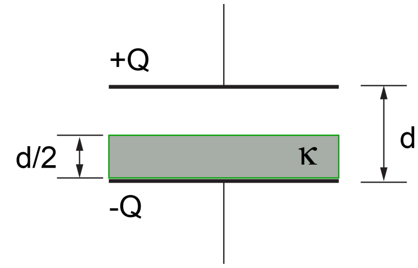
a. V_3 = 7.8 V
b. V_3 = 2.1 V
c. V_3 = 1.1 V
d. V_3 = 0.97 V
e. V_3 = 14 V

19) What is $V_{battery}$, the voltage across the battery?

a. $V_{battery}$ = 2.1 V
b. $V_{battery}$ = 0.97 V
c. $V_{battery}$ = 1.1 V

The next two questions pertain to the situation described below.

A parallel plate capacitor is constructed with a dielectric slab with $\kappa = 1.5$ inserted between the plates. The area of each plate is 5 cm^2, and the distance between the two plates is 1 mm. Assume the infinite plane approximation.



20) If we fix the charge on the capacitor to be $Q = 6\times10^{-11}$ C, what is the potential difference between the top and bottom plates? Note that in the region containing the dielectric medium, the electric field is $E = E_0 / \kappa$, where E_0 is the electric field in vacuum.

a. $\Delta V = 4.5$ V
b. $\Delta V = 14$ V
c. $\Delta V = 2.7$ V
d. $\Delta V = 6.8$ V
e. $\Delta V = 11$ V

21) What is the capacitance of this configuration? (Note: 1 pF = 10^{-12} F)

a. C = 4.4 pF
b. C = 5.3 pF
c. C = 22 pF