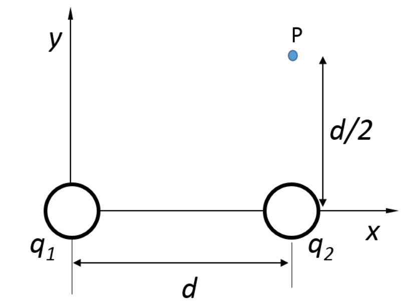
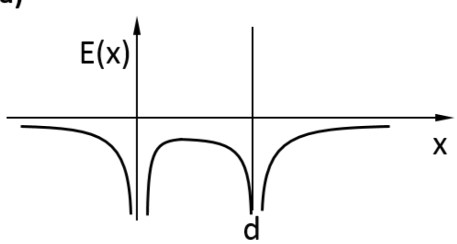
The next three questions pertain to the situation described below.

Two point charges $q_1 = 4.2 \times 10^{-6}$ C and $q_2 = 6.3 \times 10^{-6}$ C are fixed on the x axis. q_1 is located at the origin and q_2 is a distance $d = 0.85$ m to the right as shown in the figure.

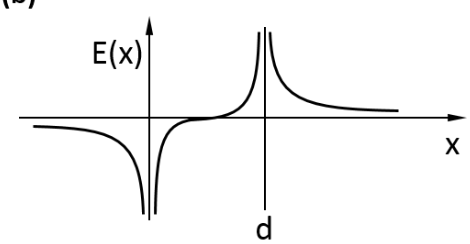


1) Which of the following plots best represents the x component of the net electric field $E(x)$ along the x axis due to the two charges? $E(x)$ is defined to be positive when pointing to the right, and negative when pointing to the left.

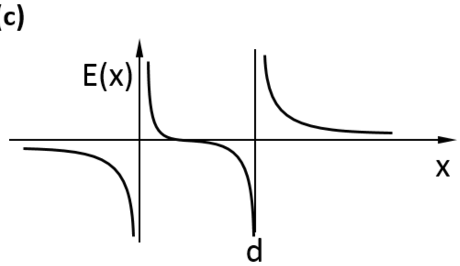
(a)



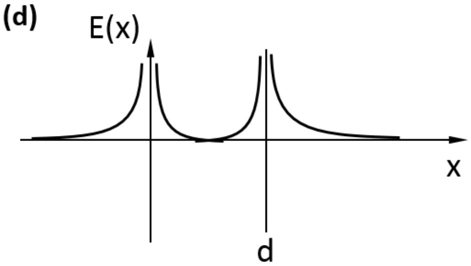
(b)



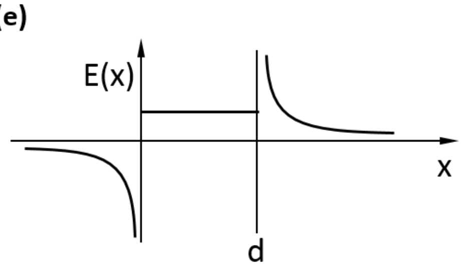
(c)



(d)



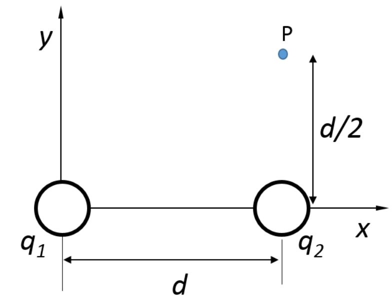
(e)



a. (a)
b. (b)
c. (c)
d. (d)
e. (e)

2) Problem statement repeated from previous page.

Two point charges $q_1 = 4.2 \times 10^{-6}$ C and $q_2 = 6.3 \times 10^{-6}$ C are fixed on the x axis. q_1 is located at the origin and q_2 is a distance $d = 0.85$ m to the right as shown in the figure.



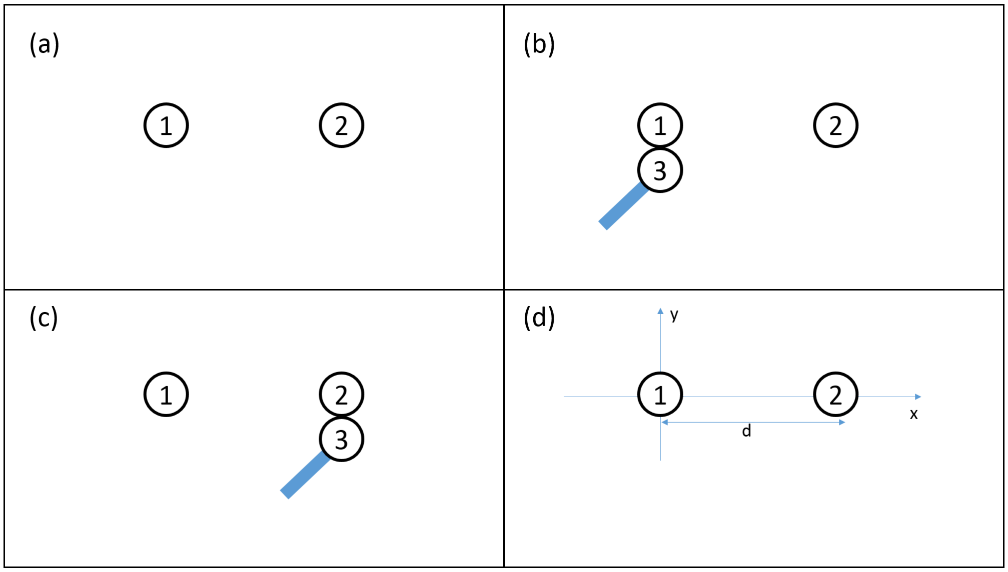
What is the y component of the electric field due to the two charges at point P a distance 0.425 m above charge q_2?

a. $E_y(P) = 37400$ N/C
b. $E_y(P) = 3.33 \times 10^5$ N/C
c. $E_y(P) = 18700$ N/C
d. $E_y(P) = 3.56 \times 10^5$ N/C
e. $E_y(P) = 3.14 \times 10^5$ N/C

3) What is the magnitude of the electric field due to the two charges at point P a distance 0.425 m above charge q_2?

a. $|E(P)| = 3.14 \times 10^5$ N/C
b. $|E(P)| = 3.7 \times 10^5$ N/C
c. $|E(P)| = 3.35 \times 10^5$ N/C

The next two questions pertain to the situation described below.



Identical isolated conducting spheres 1 and 2 have equal charges Q=3.8 × 10^{-6} C and are separated by a distance that is large compared with their diameters. A third identical sphere 3, having an insulating handle and initially uncharged, is touched first to sphere 1 (figure part b), then to sphere 2 (figure part c), and finally removed (figure part d).

4) What is the final charge on sphere 2?

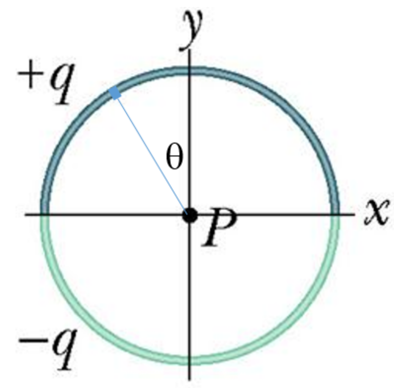
a. $Q_2 = 2.85 \times 10^{-6}$ C
b. $Q_2 = 5.7 \times 10^{-6}$ C
c. $Q_2 = 1.9 \times 10^{-6}$ C

5) If the position of sphere 1 is at $x = 0$ and the position of sphere 2 is at $x = d$, what region along the x-axis contains a point (outside of the spheres) where the electric field is zero? (see figure part d)

a. $d < x < \infty$
b. $0 < x < d$
c. $\infty < x < 0$

The next two questions pertain to the situation described below.

In the figure, two curved plastic rods, one of charge $+q$ and the other of charge $-q$, form a circle of radius R in an xy plane. The x axis passes through their connecting points, and the charge is distributed uniformly on both rods.



6) What is the direction of the net electric field at the center of the circle?

a. +x
b. -x
c. -y
d. zero
e. +y

7) Which integral expression represents the x-component of the electric field due to the top semicircle of charge (+q)?

a. $E_x = \int_{-\pi/2}^{\pi/2} \frac{kqd\theta}{R^2}$

b. $E_x = \int_{-\pi/2}^{\pi/2} \frac{kq\cos(\theta)d\theta}{\pi R^2}$

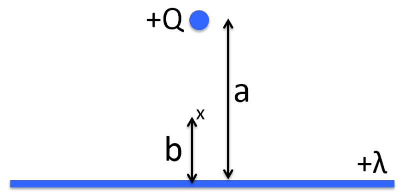
c. $E_x = \int_{-\pi/2}^{\pi/2} \frac{kq\sin(\theta)d\theta}{\pi R^2}$

d. $E_x = \int_{-\pi/2}^{\pi/2} \frac{kq\sin(\theta)d\theta}{R^2}$

e. $E_x = \int_{-\pi/2}^{\pi/2} \frac{kq\cos(\theta)d\theta}{R^2}$

The next two questions pertain to the situation described below.

A positive charge $+Q$ is placed a distance a from an infinite line of charge with positive linear charge density λ. The charge is then moved towards the line of charge to a distance b from the line of charge as shown.



8) What is the sign of the work done by the electric field on the charge ($+Q$) when it moves from position a to position b?

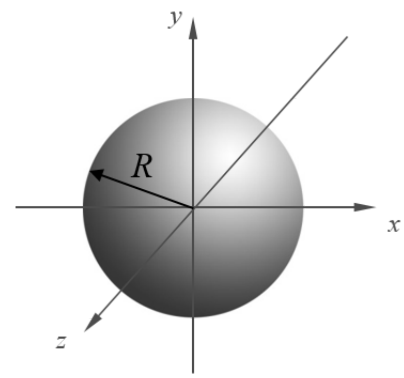
a. zero
b. positive
c. negative

9) What is the magnitude of the change in potential energy when the charge ($+Q$) moves from position a to b?

a. $|\Delta U| = |2\, k\, \lambda\, Q\, (1/b - 1/a)|$
b. $|\Delta U| = |2\, k\, \lambda\, Q\, \ln(b/a)|$
c. $|\Delta U| = |2\, k\, \lambda\, Q\, (a - b)|$

The next three questions pertain to the situation described below.

A solid spherical conductor centered at the origin has radius $R = 0.4$ m, and carries a total positive charge $Q = 5 \times 10^{-6}$ C.



10) What is the magnitude of the electric field, $|E|$, at a radius of 0.8 m from the origin?

a. $|E| = 2.81 \times 10^5$ N/C
b. $|E| = 1.41$ N/C
c. $|E| = 70300$ N/C

11) If we define the electric potential to be zero at infinity, what is the potential V at a radius of 0.8 m from the origin? (Note, this is outside of the conducting sphere)

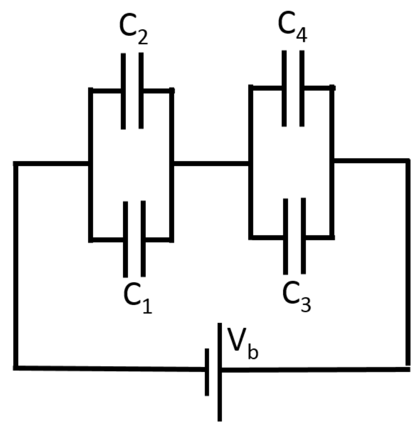
a. V = 0 Volts
b. $V = -1.13 \times 10^5$ Volts
c. V = -56300 Volts
d. $V = 1.13 \times 10^5$ Volts
e. V = 56300 Volts

12) If we define the electric potential V to be zero at infinity, what is the potential V at a radius of 0.1 m from the origin? (Note, this is inside the conducting sphere.)

a. V = 0 Volts
b. $V = 4.5 \times 10^5$ Volts
c. $V = -4.5 \times 10^5$ Volts
d. $V = 1.13 \times 10^5$ Volts
e. $V = -1.13 \times 10^5$ Volts

The next three questions pertain to the situation described below.

Four capacitors are connected to a 9 Volt battery as shown in the diagram.



$C_1 = 5.8 \times 10^{-6}$ F

$C_2 = 1.16 \times 10^{-5}$ F

$C_3 = 1.74 \times 10^{-5}$ F

$C_4 = 2.32 \times 10^{-5}$ F

13) Which capacitor has the same voltage across it as C_1?

a. C_2
b. C_3
c. No other capacitor has the same voltage as C_1.

14) What is the equivalent total capacitance of the 4 capacitors?

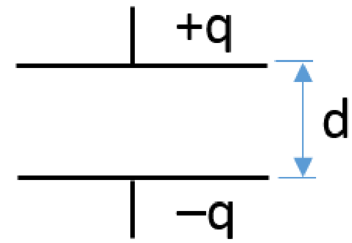
a. $C_{eq} = 3.48 \times 10^{-5}$ F
b. $C_{eq} = 5.8 \times 10^{-5}$ F
c. $C_{eq} = 4.35 \times 10^{-6}$ F
d. $C_{eq} = 1.38 \times 10^{-5}$ F
e. $C_{eq} = 1.22 \times 10^{-5}$ F

15) What is the charge on capacitor C_1?

a. $Q_1 = 1.1 \times 10^{-4}$ C
b. $Q_1 = 5.48 \times 10^{-5}$ C
c. $Q_1 = 7.31 \times 10^{-5}$ C
d. $Q_1 = 3.65 \times 10^{-5}$ C
e. $Q_1 = 2.74 \times 10^{-5}$ C

The next three questions pertain to the situation described below.

The figure shows a parallel-plate capacitor of plate area $A = 0.0226\ \text{m}^2$ and plate separation $d = 0.0124$ m. A potential difference $V_0 = 85.5$ Volts is applied between the plates. The battery is then disconnected.

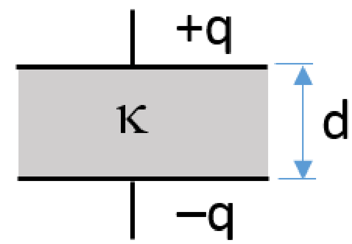


16) What is the charge on the positive plate of the capacitor?

a. $q = 1.38 \times 10^{-9}$ C
b. $q = 2.07 \times 10^{-9}$ C
c. $q = 2.76 \times 10^{-9}$ C

17) Now a dielectric slab of thickness d and dielectric constant $\kappa = 2.65$ is placed between the plates as shown.

What is the capacitance C_1 with the slab in place?

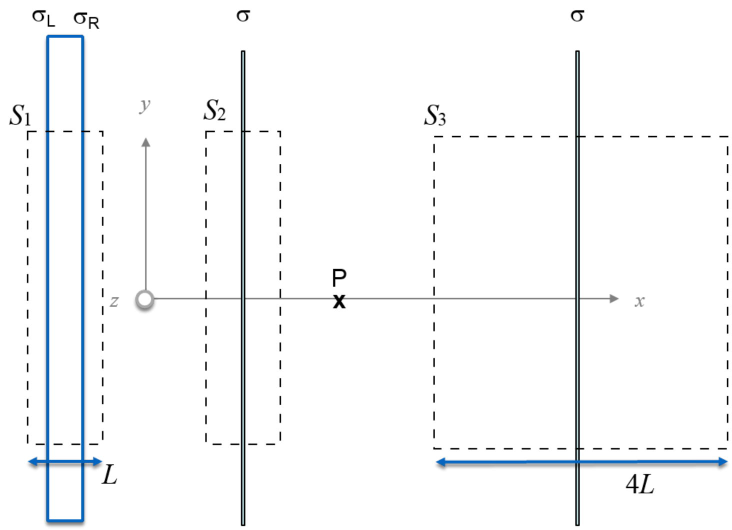


a. $C_1 = 4.27 \times 10^{-11}$ F
b. $C_1 = 6.09 \times 10^{-12}$ F
c. $C_1 = 1.61 \times 10^{-11}$ F

18) Compare U_0, the energy stored in the capacitor before the dielectric was inserted, to U_1, the energy stored in the capacitor after the dielectric was inserted.

a. $U_0 = U_1$
b. $U_0 < U_1$
c. $U_0 > U_1$

The next three questions pertain to the situation described below.



The figure shows three infinite planes. The right two planes are insulating with uniform charge density $\sigma = 5$ C/m^2. The left plane is uncharged ($\sigma_L+\sigma_R=0$)and conducting. Also shown in the figure are three Gaussian surfaces labelled S_1, S_2 and S_3. All three Gaussian surfaces have identical dimensions in the *yz* plane, but surface S_3 is 4 times as wide in the *x* direction.

19) What is the contribution to the *x* component of the electric field at the marked point *P* from the plane on the right? (e.g. ignore the conducting plane and the middle plane for this calculation.)

a. -5.65×10^{11} N/C
b. -2.82×10^{11} N/C
c. 2.82×10^{11} N/C
d. 5.65×10^{11} N/C
e. 0 N/C

20) What is the induced charge on the right side of the conducting slab?

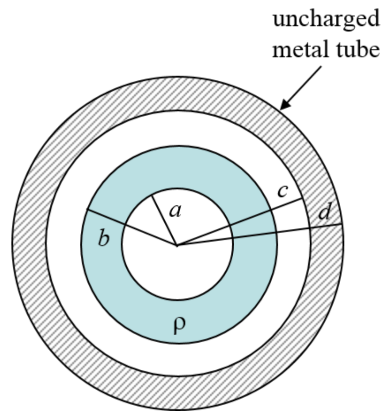
a. $\sigma_R = -10$ C/m^2
b. $\sigma_R = -2.5$ C/m^2
c. $\sigma_R = -5$ C/m^2

21) Compare the total flux through Gaussian surface S_1 with the total flux through surface S_3 .

a. $\Phi_1 > \Phi_3$
b. $\Phi_1 < \Phi_3$
c. $\Phi_1 = \Phi_3$

The next four questions pertain to the situation described below.

A hollow insulating cylinder has inner radius a=0.45 m and outer radius b=0.675 m and carries a constant charge density ρ = 3 C/m^3, as drawn in the figure. It is surrounded by a neutral metal tube, with inner radius c=0.9 m and outer radius d=1.125 m.



22) What is the magnitude of the electric field, $|E|$, at a radius of 0.743 m from the origin?

a. $|E| = 4.89 \times 10^{10}$ N/C
b. $|E| = 5.78 \times 10^{10}$ N/C
c. $|E| = 7.27 \times 10^{10}$ N/C

23) What is the magnitude of the electric field, $|E|$, at a radius of 0.99 m from the origin?

a. $|E| = 4.34 \times 10^{10}$ N/C
b. $|E| = 0$
c. $|E| = 5.45 \times 10^{10}$ N/C

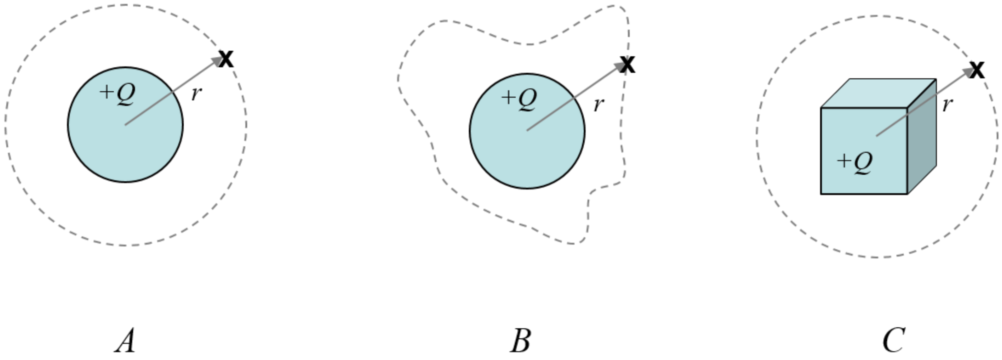
24) What is the total charge per unit length induced on the inner surface of the metal tube?

a. λ_c = -4.29 C/m
b. λ_c = -0.759 C/m
c. λ_c = -7.63 C/m
d. λ_c = -1.09 C/m
e. λ_c = -2.39 C/m

25) If the conducting shell was removed, the electric field at at a radius 1.69 m from the origin would

a. increase.
b. remain unchanged.
c. decrease.

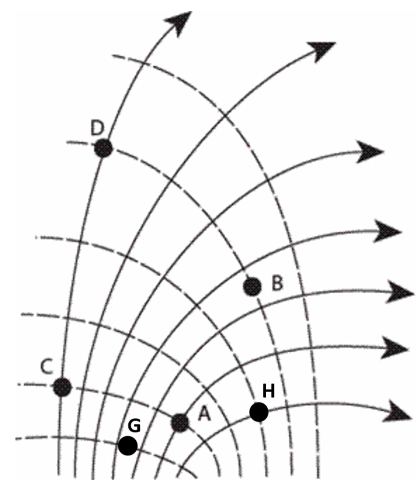
26)



Consider the two charged spheres and one charged cube and the Gaussian surfaces surrounding them as drawn in the figure. In all three cases, the total charge of the object is Q. Which statement is an accurate description of the total flux through the three surfaces?

a. The fluxes through surfaces A and B are the same, but the flux through surface C is different
b. The fluxes through all three surfaces are the same
c. The fluxes through surfaces A and C are the same, but the flux through surface B is different

The field line representation of the electric field in a certain region of space is shown in the figure. The dashed lines represent equipotential lines.



27) Compare V_{GH}, the magnitude of the potential difference between points G and H, with V_{AD} the potential difference between points A and D.

a. $V_{GH} > V_{AD}$
b. $V_{GH} < V_{AD}$
c. $V_{GH} = V_{AD}$