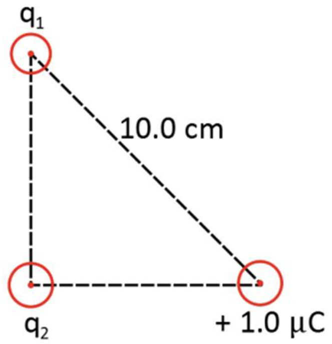
Question 1.

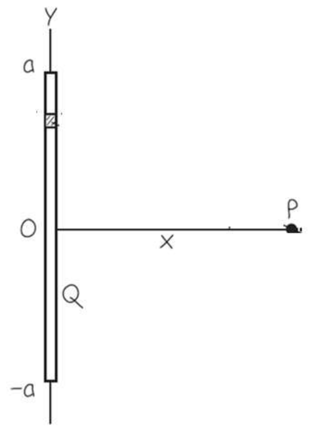
(a)

Three point charges are fixed in place in the right triangle shown below, in which $q_1 = 0.71\,\mu C$ and $q_2 = -0.67\,\mu C$. What is the magnitude and direction of the electric force on the $+1.0\,\mu C$ (let's call this q_3) charge due to the other two charges?



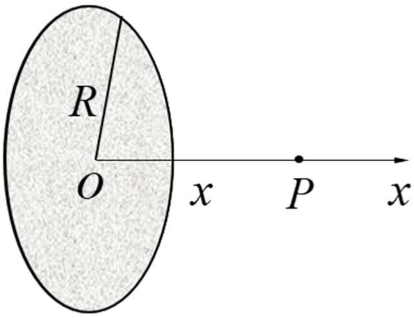
(b)

Positive charge Q is distributed uniformly along the y-axis between $y = -a$ and $y = +a$. Find the electric field at point P on the x-axis at a distance x from the origin.



(c)

A nonconducting disk of radius R has a uniform positive surface charge density σ. Find the electric field at a point along the axis of the disk a distance x from its center. Assume that x is positive.

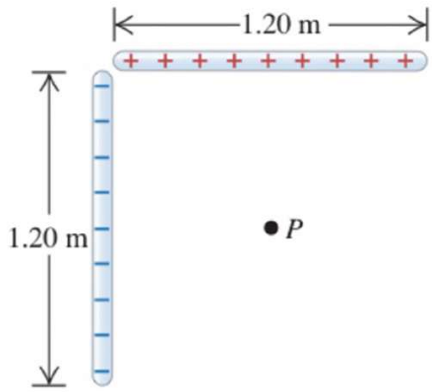


Question 2.

Point charges $q_1 = -4.5$ nC and $q_2 = +4.5$ nC are separated by 3.1 mm, forming an electric dipole. (a) Find the electric dipole moment (magnitude and direction). (b) The charges are in a uniform electric field whose direction makes an angle of 36.9° with the line connecting the charges. What is the magnitude of this field if the torque exerted on the dipole has magnitude 7.2×10^{-9} N · m?

Question 3.

Two 1.20-m nonconducting wires meet at a right angle. One segment carries +2.50 μC of charge distributed uniformly along its length, and the other carries −2.50 μC distributed uniformly along it, as shown



(a) Find the magnitude and direction of the electric field these wires produce at point P, which is 60.0 cm from each wire. (b) If an electron is released at P, what are the magnitude and direction of the net force that these wires exert on it?

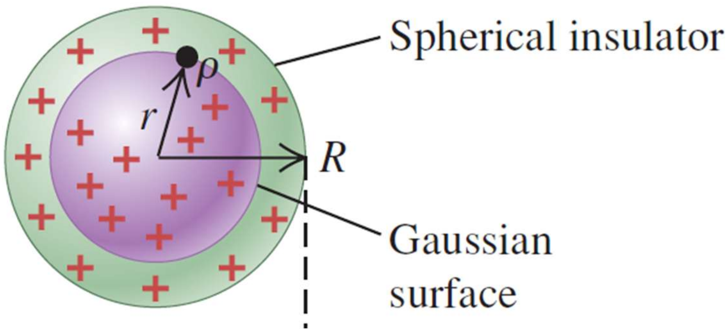
Question 4.

(a) Electric charge is distributed uniformly along an infinitely long, thin wire. The charge per unit length is λ (assumed positive). Find the electric field using Gauss's law.

(b) Use Gauss's law to find the electric field E caused by a thin, flat, infinite sheet with a uniform positive surface charge density σ.

(c)

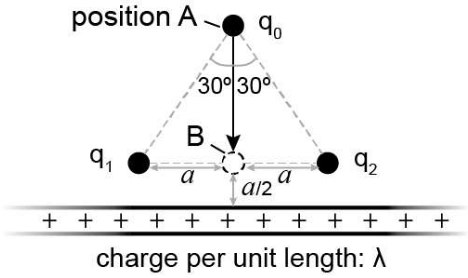
Positive electric charge Q is distributed uniformly *throughout the volume* of an *insulating* sphere with radius R. Find the magnitude of the electric field at a point P a distance r from the center of the sphere.



(d) A spherical conductor has a radius of 0.04 m. On the surface an amount of charge is evenly distributed with a surface charge density of σ = 6.5 nC/m^2. What is the strength of the electric field at the surface of this conductor?

Question 5. A solid conductor with three cavities carries a total charge of +7 nC. Within the first cavity, insulated from the conductor, is a point charge of -5 nC. Within the second cavity, insulated from the conductor, is a point charge of 6 nC. Within the third cavity, insulated from the conductor, is a point charge of 8 nC. (a) How much charge is on each surface (inner and outer) of the conductor? (b) What is the electric field flux across a closed surface that encloses the conductor entirely? (c) What is the electric field flux across a closed surface within cavity 1 that encloses the first charge of (-5 nC)?

Question 6. Two charged q_1 and q_2 separated by $2a$ are both at a distance of $a/2$ from an infinitely long line charge (charge per unit length λ). Another charge q_0 moves from A to B (the middle point between q_1 and q_2) as depicted by the figure. (a) What is the change of potential energy of the system by the process? (b) What is the electrostatic force experienced by the charge q_0 at position A? (c) What is the electrostatic force experienced by the charge q_0 at position B? Express your answer in terms of λ, a, q_0, q_1 and q_2 and needed constants.

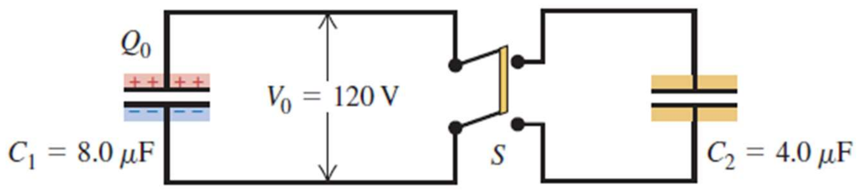


Question 7.

Two concentric spherical conducting shells are separated by vacuum. The inner shell has total charge +Q and outer radius r_a and the outer shell has charge -Q and inner radius r_b. Find the capacitance of this spherical capacitor.

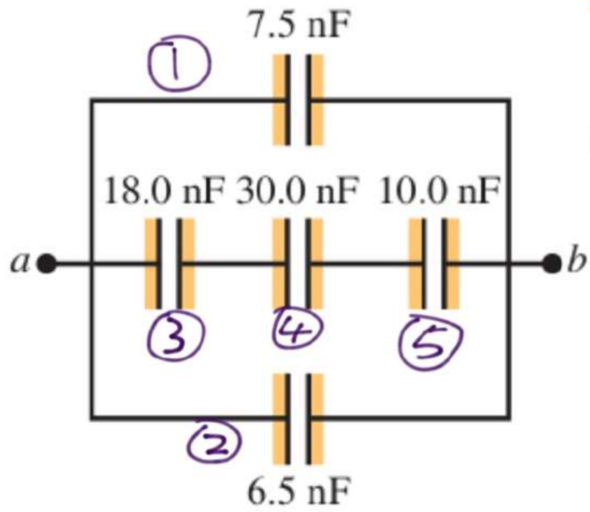
Question 8.

We connect a capacitor $C_1 = 8.0\ \mu F$ to a power supply, charge it to a potential difference $V_0 = 120$ V, and disconnect the power supply (Fig. 24.12). Switch S is open. (a) What is the charge Q_0 on C_1? (b) What is the energy stored in C_1? (c) Capacitor $C_2 = 4.0\ \mu F$ is initially uncharged. We close switch S. After charge no longer flows, what is the potential difference across each capacitor, and what is the charge on each capacitor? (d) What is the final energy of the system?



Question 9

For the system of capacitors shown in Fig. a potential difference of 25 V is maintained across *ab*. (a) What is the equivalent capacitance of this system between *a* and *b*? (b) How much charge is stored by this system? (c) How much charge does the 6.5-nF capacitor store? (d) What is the potential difference across the 7.5-nF capacitor?



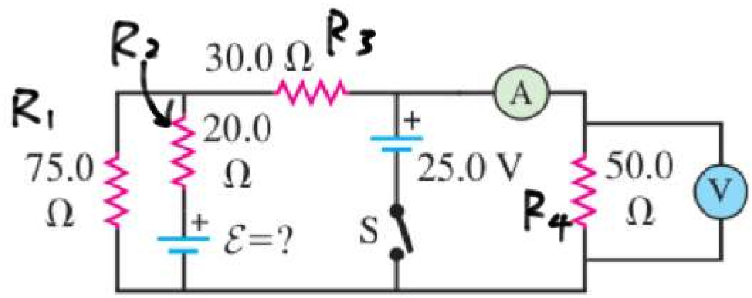
Question 10. Suppose the parallel plates each have an area of 2000 cm^2 and are 1.0 cm apart. We connect the capacitor to a power supply, charge it to a potential difference V_0 = 5.0 kV and disconnect the power supply. We then insert a sheet of insulating plastic material between the plates, completely filling the space between them. We find that the potential difference decreases to 1.00 kV while the charge on each capacitor plate remains constant. Find (a) the original capacitance C_0 (b) the magnitude of charge Q on each plate; (c) the capacitance C after the dielectric is inserted; (d) the magnitude of the induced charge Q_i on each face of the dielectric; (e) the electric field E after the dielectric is inserted. (e) Find the energy stored in the electric field of the capacitor and energy density, before and after the dielectric sheet is inserted.

Question 11. An 18-gauge copper wire (the size usually used for lamp cords), with a diameter of 1.02 mm carries a constant current of 1.67 A to a 200-W lamp. The free-electron density in the wire is 8.5×1028 per cubic meter. Find (a) the current density and (b) the drift speed. (c) If we heat up the copper wire, will the current density decrease or increase? Explain why.

If the wire has a cross-sectional area of 8.20 × 10^{-7} m^2. Find (d) the electric-field magnitude in the wire; (e) the potential difference between two points in the wire 50.0 m apart; (f) the resistance of a 50.0-m length of this wire

Question 12.

In the circuit shown in Fig. the batteries have negligible internal resistance and the meters are both idealized. With the switch S open, the voltmeter reads 15.0 V. (a) Find the emf $\mathcal{E}$ of the battery. (b) What will the ammeter read when the switch is closed?



(c) An emf source with $\mathcal{E} = 120$ V, a resistor with $R = 80.0\ \Omega$, and a capacitor with $C = 4.00\ \mu$F are connected in series. As the capacitor charges, when the current in the resistor is 0.900 A, what is the magnitude of the charge on each plate of the capacitor?