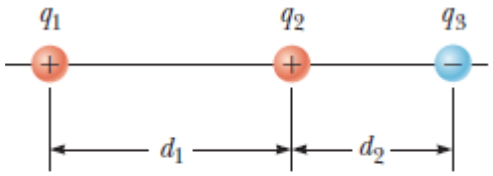
Problems:

Section 23.1 Properties of Electric Charges
2- (a) Calculate the number of electrons in a small, electrically neutral silver pin that has a mass of 10.0 g. Silver has 47 electrons per atom, and its molar mass is 107.87 g/mol.
Section 23.3 Coulomb's Law
9. A 7.50-nC point charge is located 1.80 m from a 4.20-nC point charge. (a) Find the magnitude of the electric force that one particle exerts on the other. (b) Is the force attractive or repulsive?
12. Three point charges lie along a straight line as shown in Figure P23.12, where q_1 = 6.00 µC, q_2 = 1.50 µC, and $q3$ = 22.00 µC. The separation distances are d_1 = 3.00 cm and d_2 = 2.00 cm. Calculate the magnitude and direction of the net electric force on (a) q_1, (b) q_2, and (c) q_3.
 Figure P23.12
13. Two small beads having positive charges q_1 = 3q and q_2 = q are fixed at the opposite ends of a horizontal insulating rod of length d = 1.50 m. The bead with charge q_1 is at the origin. As shown in Figure P23.13, a third small, charged bead is free to slide on the rod. (a) At what position x is the third bead in equilibrium? (b) Can the equilibrium be stable?

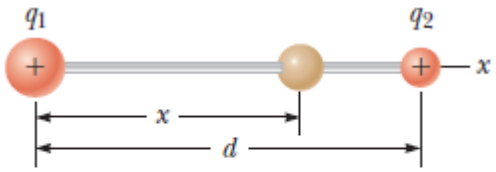


Figure P23.13 Problems 13 and 14.

15. Three charged particles are located at the corners of an equilateral triangle as shown in Figure P23.15. Calculate the total electric force on the 7.00-µC charge.

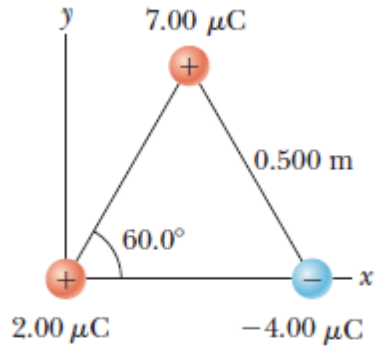


Figure P23.15 Problems 15 and 30.

Section 23.4 Analysis Model: Particle in a Field (Electric)

25. Four charged particles are at the corners of a square of side a as shown in Figure P23.25. Determine (a) the electric field at the location of charge q and (b) the total electric force exerted on q.

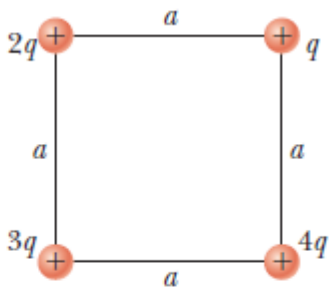


Figure P23.25

26. Three point charges lie along a circle of radius *r* at angles of 30^0, 150^0, and 270^0 as shown in Figure P23.26.

Find a symbolic expression for the resultant electric field at the center of the circle.

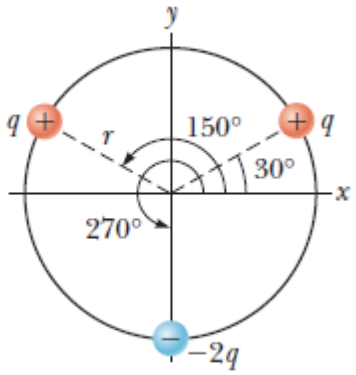


Figure P23.26

27. Two equal positively charged particles are at opposite corners of a trapezoid as shown in Figure P23.27. Find symbolic expressions for the total electric field at (a) the point *P* and (b) the point *P**.

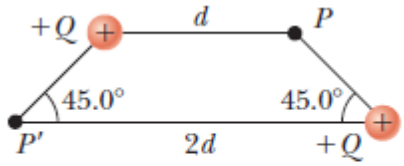


Figure P23.27

Section 23.6 Electric Field Lines

49. Figure P23.49 shows the electric field lines for two charged particles separated by a small distance.

(a) Determine the ratio q_1/q_2.

(b) What are the signs of q_1 and q_2?

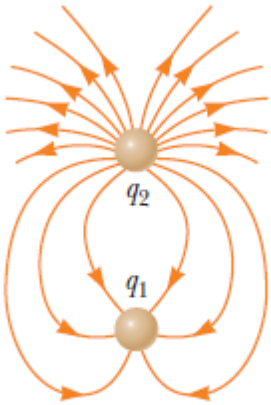


Figure P23.49

Section 25.1 Electric Potential and Potential Difference

1. Oppositely charged parallel plates are separated by 5.33 mm. A potential difference of 600 V exists between the plates.

(a) What is the magnitude of the electric field between the plates?

(b) What is the magnitude of the force on an electron between the plates?

(c) How much work must be done on the electron to move it to the negative plate if it is initially positioned 2.90 mm from the positive plate?

Section 25.3 Electric Potential and Potential Energy Due to Point Charges

Note: Unless stated otherwise, assume the reference level of potential is $V = 0$ at $r = \infty$

13. Two point charges are on the y axis. A 4.50-μC charge is located at $y = 1.25$ cm, and a 22.24-μC charge is located at $y = 21.80$ cm. Find the total electric potential at (a) the origin and (b) the point whose coordinates are (1.50 cm, 0).

14. The two charges in Figure P25.14 are separated by d =2.00 cm.

Find the electric potential at (a) point A and (b) point B, which is halfway between the charges.

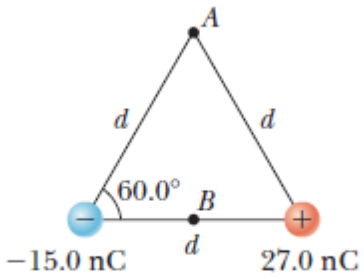


Figure P25.14

18. The two charges in Figure P25.18 are separated by a distance d = 2.00 cm, and Q = 15.00 nC. Find (a) the electric potential at A, (b) the electric potential at B, and (c) the electric potential difference between B and A.

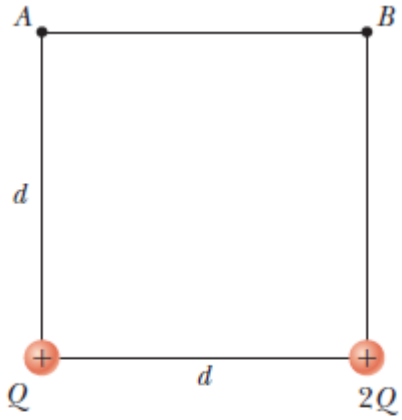


Figure P25.18

Section 25.4 Obtaining the Value of the Electric Field from the Electric Potential

36. Figure P25.36 represents a graph of the electric potential in a region of space versus position x, where the electric field is parallel to the x axis. Draw a graph of the x component of the electric field versus x in this region.

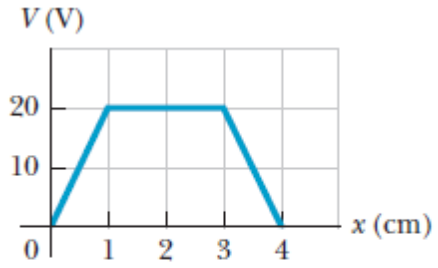


Figure P25.36

Section 26.1 Definition of Capacitance

1. (a) When a battery is connected to the plates of a 3.00- μF capacitor, it stores a charge of 27.0 μC. What is the voltage of the battery? (b) If the same capacitor is connected to another battery and 36.0 μC of charge

is stored on the capacitor, what is the voltage of the battery?

Section 26.2 Calculating Capacitance

5. A 50.0-m length of coaxial cable has an inner conductor that has a diameter of 2.58 mm and carries a charge of 8.10 μC. The surrounding conductor has an inner diameter of 7.27 mm and a charge of 28.10 μC.

Assume the region between the conductors is air.

(a) What is the capacitance of this cable? (b) What is the potential difference between the two conductors?

Section 26.3 Combinations of Capacitors

13. Two capacitors, $C1$ = 5.00 μF and $C2$ = 12.0 μF, are connected in parallel, and the resulting combination is connected to a 9.00-V battery. Find (a) the equivalent capacitance of the combination, (b) the potential difference across each capacitor, and (c) the charge stored on each capacitor.

14. What If? The two capacitors of Problem 13 ($C1$ = 5.00 µF and $C2$ = 12.0 µF) are now connected in series and to a 9.00-V battery. Find (a) the equivalent capacitance of the combination, (b) the potential difference across each capacitor, and (c) the charge on each capacitor.

19. For the system of four capacitors shown in Figure P26.19, find (a) the equivalent capacitance of the system, (b) the charge on each capacitor, and (c) the potential difference across each capacitor.

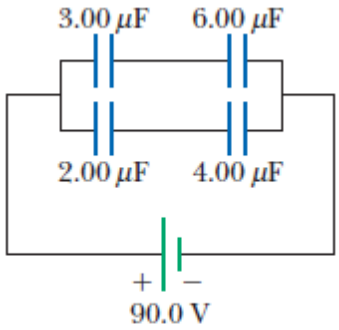


Figure P26.19

23. Four capacitors are connected as shown in Figure P26.23. (a) Find the equivalent capacitance between points a and b. (b) Calculate the charge on each capacitor, taking ΔV_{ab} = 15.0 V.

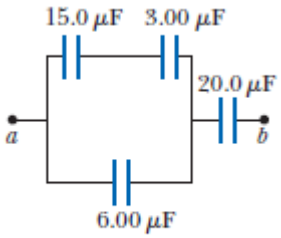


Figure P26.23

25. Find the equivalent capacitance between points *a* and *b* in the combination of capacitors shown in Figure P26.25.

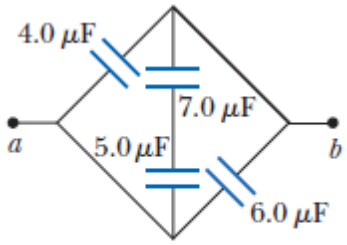


Figure P26.25

Section 26.4 Energy Stored in a Charged Capacitor

31. A 12.0-V battery is connected to a capacitor, resulting in 54.0 μC of charge stored on the capacitor. How much energy is stored in the capacitor?

Section 26.5 Capacitors with Dielectrics

43. (a) How much charge can be placed on a capacitor with air between the plates before it breaks down if the area of each plate is 5.00 cm2? (b) **What If?** Find the maximum charge if polystyrene is used between the plates instead of air.

Section 27.1 Electric Current

6. A copper wire has a circular cross section with a radius of 1.25 mm. (a) If the wire carries a current of 3.70 A, find the drift speed of the electrons in this wire.

(b) All other things being equal, what happens to the drift speed in wires made of metal having a larger number of conduction electrons per atom than copper? Explain.

Section 27.2 Resistance

16. A 0.900-V potential difference is maintained across a 1.50-m length of tungsten wire that has a cross sectional area of 0.600 mm2. What is the current in the wire?

17. An electric heater carries a current of 13.5 A when operating at a voltage of 120 V. What is the resistance of the heater?

18. Aluminum and copper wires of equal length are found to have the same resistance. What is the ratio of their radii?

Section 27.4 Resistance and Temperature

27. What is the fractional change in the resistance of an iron filament when its temperature changes from 25.0°C to 50.0°C?

29. If a certain silver wire has a resistance of 6.00 V at 20.0°C, what resistance will it have at 34.0°C?

Section 27.6 Electrical Power

39. A certain waffle iron is rated at 1.00 kW when connected to a 120-V source. (a) What current does the waffle iron carry? (b) What is its resistance?

40. The potential difference across a resting neuron in the human body is about 75.0 mV and carries a current of about 0.200 mA. How much power does the neuron release?

Section 28.2 Resistors in Series and Parallel

7. What is the equivalent resistance of the combination of identical resistors between points *a* and *b* in Figure P28.7?

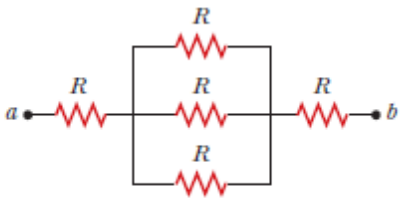


Figure P28.7

9. Consider the circuit shown in Figure P28.9. Find (a) the current in the 20.0-V resistor and (b) the potential difference between points *a* and *b.*

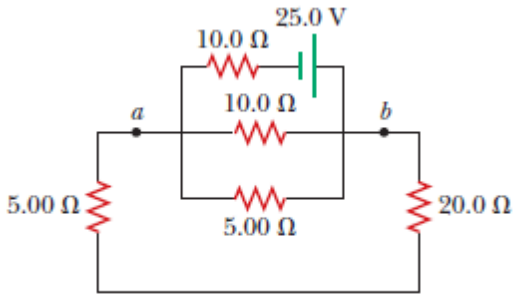


Figure P28.9

17. Consider the combination of resistors shown in Figure P28.17. (a) Find the equivalent resistance between points *a* and *b.* (b) If a voltage of 35.0 V is applied between points *a* and *b*, find the current in each resistor.

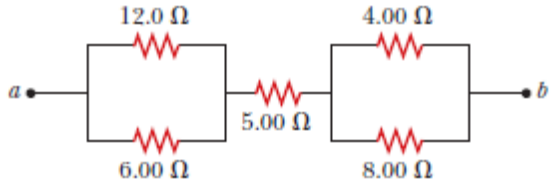


Figure P28.17

19. Calculate the power delivered to each resistor in the circuit shown in Figure P28.19.

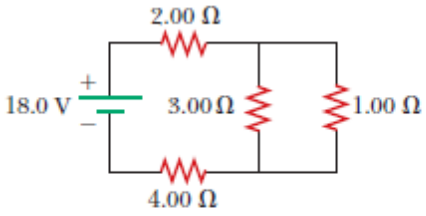


Figure P28.19

21. Consider the circuit shown in Figure P28.21. (a) Find the voltage across the 3.00-V resistor. (b) Find the current in the 3.00-V resistor.

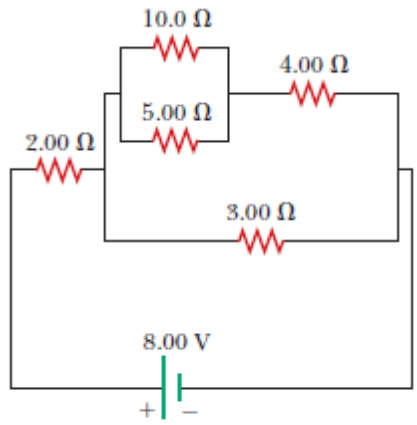


Figure P28.21

Section 28.3 Kirchhoff's Rules

22. In Figure P28.22, show how to add just enough ammeters to measure every different current. Show how to add just enough voltmeters to measure the potential difference across each resistor and across each battery.

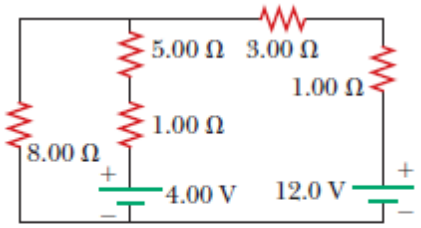


Figure P28.22 Problems 22 and 23.

23. The circuit shown in Figure P28.22 is connected for 2.00 min. (a) Determine the current in each branch of the circuit. (b) Find the energy delivered by each battery.

(c) Find the energy delivered to each resistor.

(d) Identify the type of energy storage transformation that occurs in the operation of the circuit. (e) Find the total amount of energy transformed into internal energy in the resistors.