Chapter 18
Conceptual Questions and Concepts and Calculations

CONCEPTUAL QUESTIONS

ssm Solution is in the Student Solutions Manual.

1. In Figure 18.8 the grounding wire is removed first, followed by the rod, and the sphere is left with a positive charge. If the rod were removed first, followed by the grounding wire, would the sphere be left with a charge? Account for your answer.

2. A metallic object is given a positive charge by the process of induction, as illustrated in Figure 18.8. (a) Does the mass of the object increase, decrease, or remain the same? Why? (b) What happens to the mass of the object if it is given a negative charge by induction? Explain.

3. A rod made from insulating material carries a net charge, while a copper sphere is neutral. The rod and the sphere do not touch. Is it possible for the rod and the sphere to (a) attract one another and (b) repel one another? Explain.

4. On a dry day, just after washing your hair to remove natural oils and drying it thoroughly, run a plastic comb through it. Small bits of paper will be attracted to the comb. Explain why.

5. Blow up a balloon and rub it against your shirt a number of times. In so doing you give the balloon a net electric charge. Now touch the balloon to the ceiling. On being released, the balloon will remain stuck to the ceiling. Why?

6. A proton and an electron are held in place on the x axis. The proton is at $x = -d$, while the electron is at $x = +d$. They are released simultaneously, and the only force that affects their motions is the electrostatic force of attraction that each applies to the other. Which particle reaches the origin first? Give your reasoning.

7. A particle is attached to a spring and is pushed so that the spring is compressed more and more. As a result, the spring exerts a greater and greater force on the particle. Similarly, a charged particle experiences a greater and greater force when pushed closer and closer to another particle that is fixed in position and has a charge of the same polarity. In spite of the similarity, the charged particle will *not* exhibit simple harmonic motion on being released, as will the particle on the spring. Explain why not.

8. **ssm** Identical point charges are fixed to opposite corners of a square. Where does a third point charge experience the greater force, at one of the empty corners or at the center of the square? Account for your answer.

9. On a thin, nonconducting rod, positive charges are spread evenly, so that there is the same amount of charge per unit length at every point. On another identical rod, positive charges are spread evenly over only the left half, and the same amount of negative charges are spread evenly over the right half. For each rod, deduce the *direction* of the electric field at a point that is located directly above the midpoint of the rod. Give your reasoning.

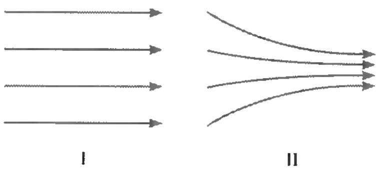
10. There is an electric field at point P. A very small charge is placed at this point and experiences a force. Another very small charge is then placed at this point and experiences a force that differs in both magnitude and direction from that experienced by the first charge. How can these two different forces result from the single electric field that exists at point P?

11. Three point charges are fixed to the corners of a square, one to a corner, in such a way that the net electric field at the empty corner is zero. Do these charges all have (a) the same sign and (b) the same magnitude (but, possibly, different signs)? Justify your answers.

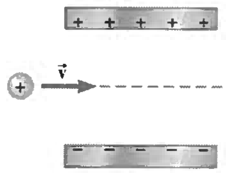
12. Review Conceptual Example 12 as an aid in answering this question. Suppose in Figure 18.21 that charges $+q$ are placed on corners 1 and 3 of the rectangle, and charges $-q$ are placed on corners 2 and 4. What is the net electric field at the center C of the rectangle?

13. In Figure 18.26 there is no place on the line through the charges where the electric field is zero, neither to the left of the positive charge, nor between the charges, nor to the right of the negative charge. Now, suppose the magnitude of the negative charge were greater than the magnitude of the positive charge. Is there any place on the line through the charges where the electric field is zero? Justify your answer.

14. **ssm** Drawings I and II show two examples of electric field lines. Decide which of the following statements are true and which are false, defending your choice in each case. (a) In both I and II the electric field is the same everywhere. (b) As you move from left to right in each case, the electric field becomes stronger. (c) The electric field in I is the same everywhere but becomes stronger in II as you move from left to right. (d) The electric fields in both I and II could be created by negative charges located somewhere on the left and positive charges somewhere on the right. (e) Both I and II arise from a single positive point charge located somewhere on the left.



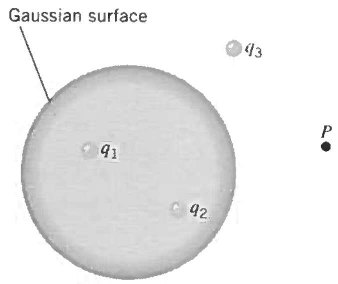
15. A positively charged particle is moving horizontally when it enters the region between the plates of a capacitor, as the drawing illustrates. (a) Draw the trajectory that the particle follows in moving through the capacitor. (b) When the particle is within the capacitor, which of the following four vectors, if any, are *parallel* to the electric field inside the capacitor: the particle's displacement, its velocity, its linear momentum, its acceleration? For each vector explain why the vector is, or is not, parallel to the electric field of the capacitor.



16. Refer to Figure 18.27. Imagine a plane that is perpendicular to a line between the charges, midway between them, and is half into and half out of the paper. The electric flux through this plane is zero. Explain why.

17. **ssm** Two charges, $+q$ and $-q$, are inside a Gaussian surface. Since the net charge inside the Gaussian surface is zero, Gauss' law states that the electric flux through the surface is also zero; that is, $\Phi_E = 0$. Does the fact that $\Phi_E = 0$ imply that the electric field $\vec{E}$ at any point on the Gaussian surface is also zero? Justify your answer. (*Hint: Imagine a Gaussian surface that encloses the two charges in Figure 18.26.*)

18. The drawing shows three charges, labeled q_1, q_2, and q_3. A Gaussian surface is drawn around q_1 and q_2. (a) Which charges determine the electric flux through the Gaussian surface? (b) Which charges produce the electric field at the point P? Justify your answers.



19. A charge $+q$ is placed inside a spherical Gaussian surface. The charge is *not* located at the center of the sphere. (a) Can Gauss' law tell us exactly where the charge is located inside the sphere? Justify your answer. (b) Can Gauss' law tell us about the magnitude of the electric flux through the Gaussian surface? Why?

CONCEPTS & CALCULATIONS

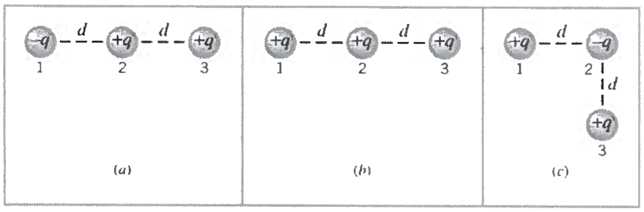
Note: Each of these problems consists of Concept Questions followed by a related quantitative Problem. The Concept Questions involve little or no mathematics. They focus on the concepts with which the problems deal. Recognizing the concepts is the essential initial step in any problem-solving technique.

69. GO **Concept Questions** Two identical metal spheres have charges of q_1 and q_2. They are brought together so they touch, and then they are separated. (a) How is the net charge on the two spheres before they touch related to the net charge after they touch? (b) After they touch and are separated, is the charge on each sphere the same? Why?

Problem Four identical metal spheres have charges of $q_A = -8.0\ \mu C$, $q_B = -2.0\ \mu C$, $q_C = +5.0\ \mu C$, and $q_D = +12.0\ \mu C$. (a) Two of the spheres are brought together so they touch and then they are separated. Which spheres are they, if the final charge on each of the two is $+5.0\ \mu C$? (b) In a similar manner, which three spheres are brought together and then separated, if the final charge on each of the three is $+3.0\ \mu C$? (c) How many electrons would have to be added to one of the spheres in part (b) to make it electrically neutral?

70. GO **Concept Questions** The drawings show three charges that have the same magnitude, but different signs. In all cases the distance d between charges 1 and 2 and between 2 and 3 is the same. (a) Draw the electrical force that each charge exerts on charge 2. Each force should be drawn in the correct direction, and its magnitude should be correct relative to that of the other force. (b) Rank the magnitudes of the net electrical force on charge 2, largest first. Explain.

Problem The magnitude of the charges is $|q| = 8.6\ \mu C$, and the distance between them is 3.8 mm. Determine the magnitude of the net force on charge 2 for each of the three drawings. Verify that your answers are consistent with your answers to the Concept Questions.



71. GO **Concept Questions** Suppose you want to neutralize the gravitational attraction between the earth and the moon by placing equal amounts of charge on each. (a) Should the charges be both positive, both negative, or one positive and the other negative? Why? (b) Do you need to know the distance between the earth and the moon to find the magnitude of the charge? Why or why not?

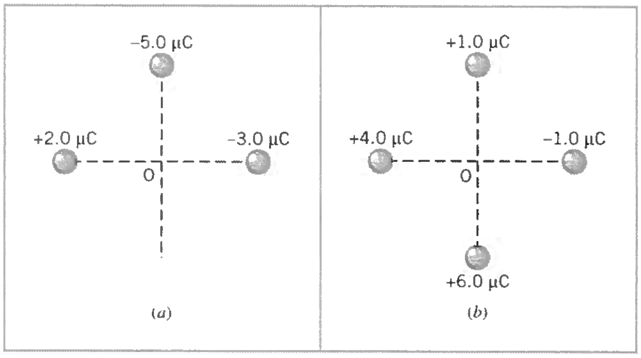
Problem The masses of the earth and moon are 5.98×10^{24} and 7.35×10^{22} kg, respectively. Identical amounts of charge are placed on each body, such that the net force (gravitational plus electrical) on each is zero. What is the magnitude of the charge?

72. GO **Concept Questions** Suppose you want to determine the electric field in a certain region of space. You have a small object of known charge and an instrument that measures the magnitude and direction of the force exerted on the object by the electric field. How would you determine the magnitude and direction of the electric field if the object were (a) positively charged and (b) negatively charged?

Problem (a) The object has a charge of $+20.0\ \mu C$ and the instrument indicates that the electric force exerted on it is $40.0\ \mu N$, due east. What are the magnitude and direction of the electric field? (b) What are the magnitude and direction of the electric field if the object has a charge of $-10.0\ \mu C$ and the instrument indicates that the force is $20.0\ \mu N$ due west?

73. GO **Concept Question** The drawing shows two situations in which charges are placed on the x and y axes. They are all located at the same distance from the origin O. Without doing any calculations, does the net electric field at the origin in part (a) have a magnitude that is greater than, less than, or equal to the magnitude of the field at the origin in part (b)? Justify your answer.

Problem The distance between each of the charges and the origin is 6.1 cm. For each of the situations shown in the drawing, determine the magnitude of the net electric field at the origin O. Check to see that your results are consistent with your answer to the Concept Question.

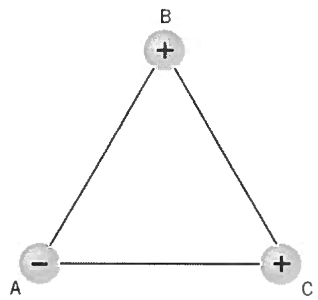


74. GO **Concept Questions** A proton and an electron are moving due east in a constant electric field that also points due east. (a) Does each experience an electric force of the same magnitude and direction? (b) What is the direction of the proton's acceleration, and what is the direction of the electron's acceleration? (c) Is the magnitude of the proton's acceleration greater than, less than, or the same as that of the electron's acceleration? Explain your answers.

Problem The electric field points due east and has a magnitude of 8.0×10^{4} N/C. Determine the magnitude of the acceleration of the proton and the electron. Check that your answers are consistent with part (c) of the Concept Questions.

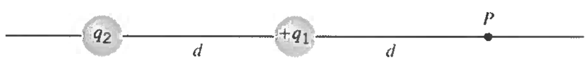
* 75. GO **Concept Questions** Three point charges have equal magnitudes, two being positive and one negative. These charges are fixed to the corners of an equilateral triangle, as the drawing shows. (a) The charge at any one corner experiences forces from the charges at the other corners. Do the individual forces exerted by the charges have the same or different magnitudes? (b) At which one or more corners does (do) the charge(s) experience a net force that has the greatest magnitude? (c) At which one or more corners does (do) the charge(s) experience a net force that has the smallest magnitude?

Problem The magnitude of each of the charges is $5.0\ \mu C$, and the lengths of the sides of the triangle are 3.0 cm. Calculate the magnitude of the net force that each charge experiences. Be sure that your answers are consistent with your answers to the Concept Questions.



* 76. GO **Concept Questions** The drawing shows a positive point charge $+q_1$, a second point charge q_2 that may be positive or negative, and a spot labeled P, all on the same straight line. The distance d between the two charges is the same as the distance between q_1 and the point P. With q_2 present, the magnitude of the net electric field at P is twice what it is when q_1 is present alone. (a) When the second charge is positive, is its magnitude smaller than, equal to, or greater than the magnitude of q_1? Explain your reasoning. (b) When the second charge is negative, is its magnitude smaller than, equal to, or greater than that in question (a)? Account for your answer.

Problem Given that $q_1 = +0.50\ \mu C$, determine q_2 when it is (a) positive and (b) negative. Verify that your answers are consistent with your answers to the Concept Questions.

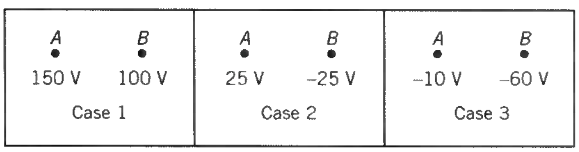


Chapter 19
Conceptual Questions and Concepts and Calculations

CONCEPTUAL QUESTIONS

ssm Solution is in the Student Solutions Manual.

1. The drawing shows three possibilities for the potentials at two points, *A* and *B*. In each case, the same positive charge is moved from *A* to *B*. In which case, if any, is the most work done on the positive charge by the electric force? Account for your answer.

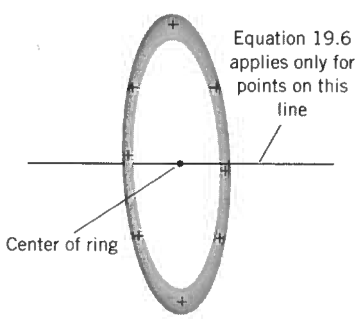


2. A positive point charge and a negative point charge have equal magnitudes. One charge is fixed to one corner of a square, and the other is fixed to another corner. On which corners should the charges be placed, so that the same potential exists at the empty corners? Give your reasoning.

3. Three point charges have identical magnitudes, but two of the charges are positive and one is negative. These charges are fixed to the corners of a square, one to a corner. No matter how the charges are arranged, the potential at the empty corner is positive. Explain why.

4. **ssm** What point charges, all having the same magnitude, would you place at the corners of a square (one charge per corner), so that both the electric field and the electric potential (assuming a zero reference value at infinity) are zero at the center of the square? Account for the fact that the charge distribution gives rise to *both* a zero field and a zero potential.

5. Positive charge is spread uniformly around a circular ring, as the drawing illustrates. Equation 19.6 gives the correct potential at points along the line perpendicular to the plane of the ring at its center. However, the equation does not give the correct potential at points that do not lie on this line. In the equation, q represents the total charge on the ring. Why does Equation 19.6 apply for points on the line, but not for points off the line?



6. The electric field at a single location is zero. Does this fact necessarily mean that the electric potential at the same place is zero? Use a spot on the line between two identical point charges as an example to support your reasoning.

7. **ssm** An electric potential energy exists when two protons are separated by a certain distance. Does the electric potential energy increase, decrease, or remain the same when (a) both protons are replaced by electrons, and (b) only one of the protons is replaced by an electron? Justify your answers.

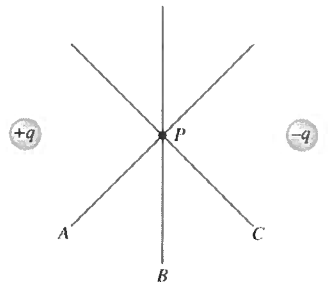
8. A proton is fixed in place. An electron is released from rest and allowed to collide with the proton. Then the roles of the proton and electron are interchanged, and the same experiment is repeated. Which is traveling faster when the collision occurs, the proton or the electron? Justify your answer.

9. The potential is constant throughout a given region of space. Is the electric field zero or nonzero in this region? Explain.

10. In a region of space where the electric field is constant everywhere, as it is inside a parallel plate capacitor, is the potential constant everywhere? Account for your answer.

11. A positive test charge is placed in an electric field. In what direction should the charge be moved relative to the field, such that the charge experiences a constant electric potential? Explain.

12. The location marked P in the drawing lies midway between the point charges $+q$ and $-q$. The blue lines labeled A, B, and C are edge-on views of three planes. Which one of these planes is an equipotential surface? Why?



Question 12

13. Imagine that you are moving a positive test charge along the line between two identical point charges. With regard to the electric potential, is the midpoint on the line analogous to the top of a mountain or the bottom of a valley when the two point charges are (a) positive and (b) negative? In each case, explain your answer.

14. Repeat question 13, assuming that you are moving a negative instead of a positive test charge.

15. The potential at a point in space has a certain value, which is not zero. Is the electric potential energy the same for every charge that is placed at that point? Give your reasoning.

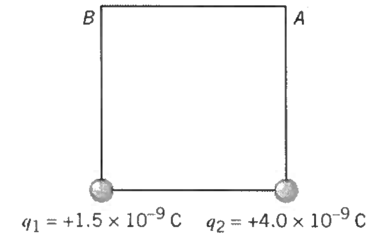
16. **ssm** A proton and an electron are released from rest at the midpoint between the plates of a charged parallel plate capacitor. Except for these particles, nothing else is between the plates. Ignore the attraction between the proton and the electron, and decide which particle strikes a capacitor plate first. Why?

17. A parallel plate capacitor is charged up by a battery. The battery is then disconnected, but the charge remains on the plates. The plates are then pulled apart. Explain whether each of the following quantities increases, decreases, or remains the same while the distance between the plates increases: (a) the capacitance of the capacitor, (b) the potential difference between the plates, (c) the electric field between the plates, and (d) the electric potential energy stored by the capacitor. Give reasons for your answers.

CONCEPTS & CALCULATIONS

Note: Each of these problems consists of Concept Questions followed by a related quantitative Problem. The Concept Questions involve little or no mathematics. They focus on the concepts with which the problems deal. Recognizing the concepts is the essential initial step in any problem-solving technique.

61. GO **Concept Questions** The drawing shows a square, on two corners of which are fixed different positive charges. A third charge (negative) is brought to one of the empty corners. (a) At which corner, A or B, is the potential greater? (b) Is the electric potential energy of the third charge positive or negative? (c) At which corner, A or B, is the magnitude of the electric potential energy greater? Explain your answers.



Problem The length of a side of the square is $L = 0.25$ m. Find the electric potential energy of a charge $q_3 = -6.0 \times 10^{-9}$ C placed at corner A and then at corner B. Compare your answers for consistency with your answers to the Concept Questions.

62. GO **Concept Questions** Charges of $-q$ and $+2q$ are fixed in place, with a distance d between them. A dashed line is drawn through the negative charge, perpendicular to the line between the charges. On the dashed line, at a distance L from the negative charge, there is at least one spot where the total potential is zero. (a) At this spot, is the magnitude of the potential from the positive charge greater than, less than, or equal to the magnitude of the potential from the negative charge? (b) Is the distance from the positive charge to the zero-potential spot greater than, less than, or equal to L? (c) How many spots on the dashed line are there where the total potential is zero? Account for your answers.

Problem The distance between the charges is $d = 2.00$ m. Find L.

63. GO **Concept Questions** An electron and a proton, starting from rest, are accelerated through an electric potential difference of the same magnitude. In the process, the electron acquires a speed v_e, while the proton acquires a speed v_p. (a) As each particle accelerates from rest, it gains kinetic energy. Does it gain or lose electric potential energy? (b) Does the electron gain more, less, or the same amount of kinetic energy as the proton does? (c) Is v_e greater than, less than, or equal to v_p? Justify your answers.

Problem Find the ratio v_e/v_p. Verify that your answer is consistent with your answers to the Concept Questions.

64. GO **Concept Questions** A positive point charge is surrounded by an equipotential surface A, which has a radius of r_A. A positive test charge moves from surface A to another equipotential surface B, which has a radius of r_B. In the process, the electric force does negative work. (a) Does the electric force acting on the test charge have the same or opposite direction as the displacement of the test charge? (b) Is r_B greater than or less than r_A? Explain your answers.

Problem The positive point charge is $q = +7.2 \times 10^{-8}$ C, and the test charge is $q_0 = +4.5 \times 10^{-11}$ C. The work done as the test charge moves from surface A to surface B is $W_{AB} = -8.1 \times 10^{-9}$ J. The radius of surface A is $r_A = 1.8$ m. Find r_B. Check to see that your answer is consistent with your answers to the Concept Questions.

65. GO **Concept Questions** Two capacitors have the same plate separation. However, one has square plates, while the other has circular plates. The square plates are a length L on each side, and the diameter of the circular plates is L. (a) If the same dielectric material were between the plates in each capacitor, which one would have the greater capacitance? (b) By putting different dielectric materials between the capacitor plates, we can make the two capacitors have the same capacitance. Which capacitor should contain the dielectric material with the greater dielectric constant? Give your reasoning in each case.

Problem The capacitors have the same capacitance because they contain different dielectric materials. The dielectric constant of the material between the square plates has a value of $\kappa_{\text{square}} = 3.00$. What is the dielectric constant κ_{circle} of the material between the circular plates? Be sure that your answer is consistent with your answers to the Concept Questions.

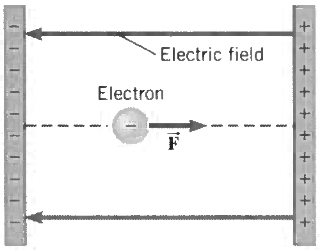
66. GO **Concept Questions** Capacitor A and capacitor B both have the same voltage across their plates. However, the energy of capacitor A can melt m kilograms of ice at 0 °C, while the energy of capacitor B can boil away the same amount of water at 100 °C. (a) Which requires more energy, melting the ice or boiling the water? (b) Which capacitor has the greater capacitance? Explain your answers.

Problem The capacitance of capacitor A is 9.3 μF. What is the capacitance of capacitor B? Be sure that your answer is consistent with your answers to the Concept Questions.

* **67.** GO **Concept Questions** During a lightning flash, a potential difference $V_{\text{cloud}} - V_{\text{ground}}$ exists between a cloud and the ground. As a result, negative electric charge is transferred from the ground to the cloud. (a) As the charge moves from the ground to the cloud, work is done on the charge by the electric force. How is this work related to the potential difference and the charge q? (b) If this work could be used to accelerate an automobile of mass m from rest, what would be the automobile's final speed? Express your answer in terms of the potential difference, the charge, and the mass of the automobile. (c) If this work could all be converted into heat, what mass m of water could be heated so that its temperature increases by ΔT? Write your answer in terms of the potential difference, the charge, the mass, the specific heat capacity c of water, and ΔT.

Problem Suppose a potential difference of $V_{\text{cloud}} - V_{\text{ground}} = 1.2 \times 10^9$ V exists between the cloud and the ground, and $q = -25$ C of charge is transferred from the ground to the cloud. (a) How much work $W_{\text{ground-cloud}}$ is done on the charge by the electric force? (b) If the work done by the electric force were used to accelerate a 1100-kg automobile from rest, what would be its final speed? (c) If the work done by the electric force were converted into heat, how many kilograms of water at 0 °C could be heated to 100 °C?

* **68.** GO **Concept Questions** An electron is released at the negative plate of a parallel plate capacitor and accelerates to the positive plate (see the drawing). (a) As the electron gains kinetic energy, does its electric potential energy increase or decrease? Why? (b) The difference in the electron's electric potential energy between the positive and negative plates is $\text{EPE}_{\text{positive}} - \text{EPE}_{\text{negative}}$. How is this difference related to the charge on the electron ($-e$) and to the difference $V_{\text{positive}} - V_{\text{negative}}$ in the electric potential between the plates? (c) How is the potential difference $V_{\text{positive}} - V_{\text{negative}}$ related to the electric field within the capacitor and the displacement of the positive plate relative to the negative plate?



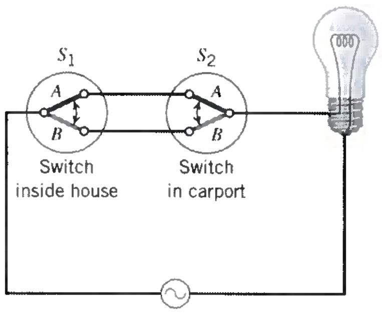
Problem The plates of a parallel plate capacitor are separated by a distance of 1.2 cm, and the electric field within the capacitor has a magnitude of 2.1×10^6 V/m. An electron starts from rest at the negative plate and accelerates to the positive plate. What is the kinetic energy of the electron just as the electron reaches the positive plate?

Chapter 20
Conceptual Questions and Concepts and Calculations

CONCEPTUAL QUESTIONS

ssm Solution is in the Student Solutions Manual.

1. The drawing shows a circuit in which a light bulb is connected to the household ac voltage via two switches, S_1 and S_2. This is the kind of wiring, for example, that allows you to turn a carport light on and off from either inside the house or out in the carport. Explain which position *A* or *B* of S_2 turns the light on when S_1 is set to (a) position *A* and (b) position *B*.



2. When an incandescent light bulb is turned on, the tungsten filament becomes white hot. The temperature coefficient of resistivity for tungsten is a positive number. What happens to the power delivered to the bulb as the filament heats up? Does the power increase, remain the same, or decrease? Justify your answer.

3. ssm Two materials have different resistivities. Two wires of the same length are made, one from each of the materials. Is it possible for each wire to have the same resistance? Explain.

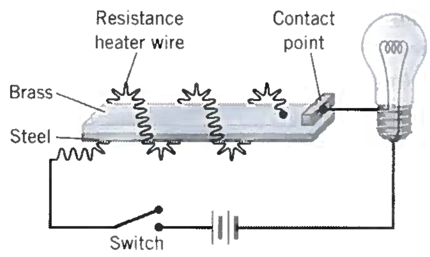
4. Does the resistance of a copper wire increase or decrease when both the length and the diameter of the wire are doubled? Justify your answer.

5. One electrical appliance operates with a voltage of 120 V, while another operates with 240 V. Based on this information alone, is it correct to say that the second appliance uses more power than the first? Give your reasoning.

6. Two light bulbs are designed for use at 120 V and are rated at 75 W and 150 W. Which light bulb has the greater filament resistance? Why?

7. Often, the instructions for an electrical appliance do not state how many watts of power the appliance uses. Instead, a statement such as "10 A, 120 V" is given. Explain why this statement is equivalent to telling you the power consumption.

8. The drawing shows a circuit that includes a bimetallic strip (made from brass and steel, see Section 12.4) with a resistance heater wire wrapped around it. When the switch is initially closed, a current appears in the circuit, because charges flow through the heater wire (which becomes hot), the strip itself, the contact point, and the light bulb. The bulb glows in response. As long as the switch remains closed, does the bulb continue to glow, eventually turn off permanently, or flash on and off? Account for your answer.



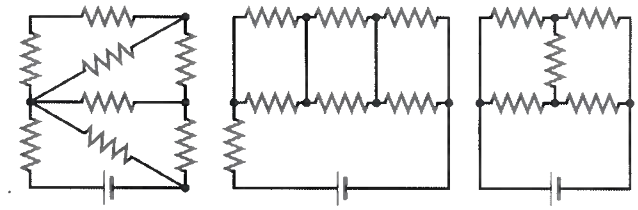
Question 8

9. The power rating of a 1000-W heater specifies the power consumed when the heater is connected to an ac voltage of 120 V. Explain why the power consumed by two of these heaters connected in series with a voltage of 120 V is not 2000 W.

10. ssm A number of light bulbs are to be connected to a single electrical outlet. Will the bulbs provide more brightness if they are connected in series or in parallel? Why?

11. A car has two headlights. The filament of one burns out. However, the other headlight stays on. Draw a circuit diagram that shows how the lights are connected to the battery. Give your reasoning.

12. In one of the circuits in the drawing, none of the resistors is in series or in parallel. Which is it? Explain.



(*a*) (*b*) (*c*)

13. ssm You have four identical resistors, each with a resistance of *R*. You are asked to connect these four together so that the equivalent resistance of the resulting combination is *R*. How many ways can you do it? There is more than one way. Justify your answers.

14. Compare the resistance of an ideal ammeter with the resistance of an ideal voltmeter and explain why the resistances are so different.

15. Describe what would happen to the current in a circuit if a voltmeter, inadvertently mistaken for an ammeter, were inserted into the circuit.

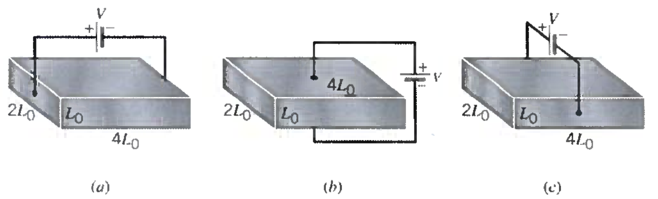
16. The time constant of a series *RC* circuit is $\tau = RC$. Verify that an ohm times a farad is equivalent to a second.

CONCEPTS & CALCULATIONS

Note: Each of these problems consists of Concept Questions followed by a related quantitative Problem. The Concept Questions involve little or no mathematics. They focus on the concepts with which the problems deal. Recognizing the concepts is the essential initial step in any problem-solving technique.

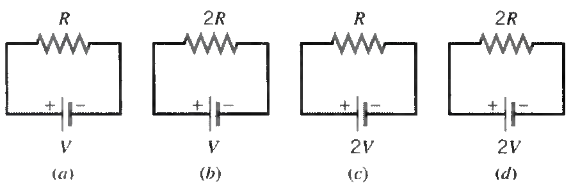
117. GO **Concept Questions** The resistance and the magnitude of the current depend on the path that the current takes. The drawing shows three situations in which the current takes different paths through a piece of material. Rank them according to (a) resistance and (b) current, largest first. Give your reasoning.

Problem Each of the rectangular pieces is made from a material whose resistivity is $\rho = 1.50 \times 10^{-2}\ \Omega \cdot m$, and the unit of length in the drawing is $L_0 = 5.00$ cm. If the material is connected to a 3.00-V battery, find (a) the resistance and (b) the current in each case. Verify that your answers are consistent with your answers to the Concept Questions.



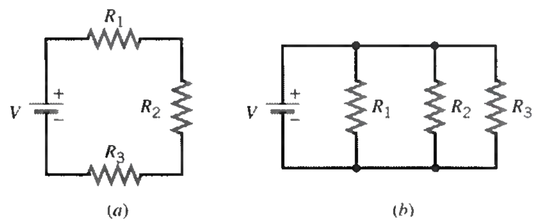
118. GO **Concept Questions** Each of the four circuits in the drawing consists of a single resistor whose resistance is either R or $2R$, and a single battery whose voltage is either V or $2V$. Rank the circuits according to (a) the power and (b) the current delivered to the resistor, largest to smallest. Explain your answers.

Problem The unit of voltage in each circuit is $V = 12.0$ V and the unit of resistance is $R = 6.00\ \Omega$. Determine (a) the power supplied to each resistor and (b) the current delivered to each resistor. Check to see that your answers are consistent with your answers to the Concept Questions.

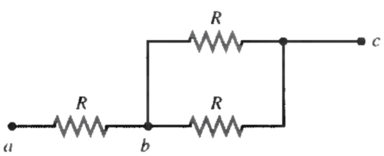


119. GO **Concept Questions** The drawing shows three different resistors in two different circuits. The resistances are such that $R_1 > R_2 > R_3$. (a) For the circuit on the left, rank the current through each resistor and the voltage across each one, largest first. (b) Repeat part (a) for the circuit on the right. Justify your answers.

Problem The battery has a voltage of $V = 24.0$ V, and the resistors have values of $R_1 = 50.0\ \Omega$, $R_2 = 25.0\ \Omega$, and $R_3 = 10.0\ \Omega$. (a) For the circuit on the left, determine the current through and the voltage across each resistor. (b) Repeat part (a) for the circuit on the right. Be sure your answers are consistent with your answers to the Concept Questions.



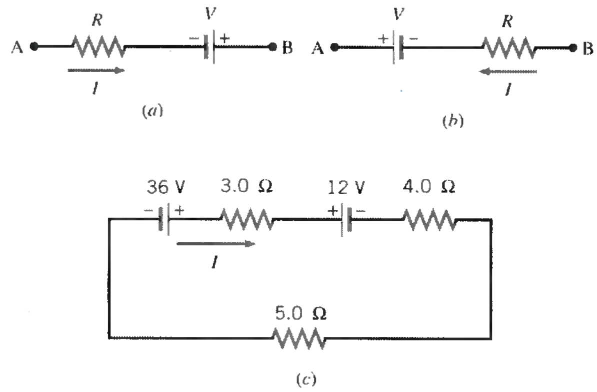
120. GO **Concept Question** The circuit in the drawing contains three identical resistors. Consider the equivalent resistance between the two points a and b, b and c, and a and c. Rank the equivalent resistances in decreasing order. Explain your reasoning.



Problem Each resistor has a value of 10.0 Ω. Determine the equivalent resistance between the points a and b, b and c, and a and c. Check to see that your answers are consistent with your answer to the Concept Question.

121. GO **Concept Question** Parts a and b of the drawing contain a resistor and a battery. Using the direction of the current as a guide, label the ends of each resistor with + and − signs. In both cases, proceed from point A to point B and determine the potential drops and potential rises. Express the drops and rises in terms of the current I, the resistance R, and the battery voltage V.

	Potential drops	Potential rises
Part a		
Part b		

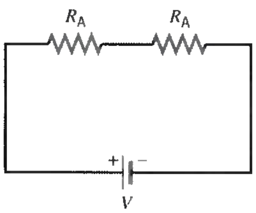


Problem Using Kirchhoff's loop rule, find the value of the current I in part c of the drawing.

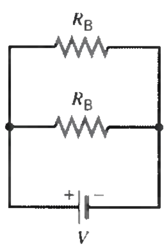
122. GO **Concept Question** Two capacitors, C_1 and C_2, are connected to a battery whose voltage is V. Recall from Section 19.5 that the electrical energy stored by each capacitor is $\frac{1}{2}C_1V_1^2$ and $\frac{1}{2}C_2V_2^2$, where V_1 and V_2 are, respectively, the voltages across C_1 and C_2. If the capacitors are connected in series, is the total energy stored by them greater than, less than, or equal to the total energy stored when they are connected in parallel? Justify your answer.

Problem The battery voltage is $V = 60.0$ V, and the capacitances are $C_1 = 2.00\ \mu$F and $C_2 = 4.00\ \mu$F. Determine the total energy stored by the two capacitors when they are wired (a) in parallel and (b) in series. Check to make sure that your answer is consistent with your answer to the Concept Question.

* **123.** GO **Concept Questions** The drawing shows two circuits, and the same battery is used in each. The two resistances R_A in circuit A are the same, and the two resistances R_B in circuit B are the same. (a) How is the total power delivered by the battery related to the equivalent resistance connected between the battery terminals and to the battery voltage? (b) When two resistors are connected in series, is the equivalent resistance of the combination greater than, smaller than, or equal to the resistance of either resistor alone? (c) When two resistors are connected in parallel, is the equivalent resistance of the combination greater than, smaller than, or equal to the resistance of either resistor alone? (d) The same total power is delivered by the battery in circuits A and B. Is R_B greater than, smaller than, or equal to R_A?



Circuit A

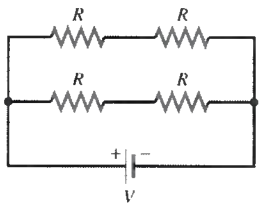


Circuit B

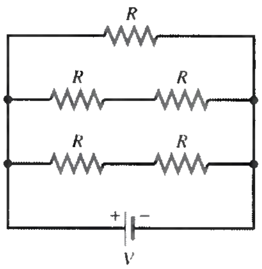
Problem Knowing that the same total power is delivered in each case, find the ratio R_B/R_A for the circuits in the drawing. Verify that your answer is consistent with your answer to Concept Question (d).

* **124.** GO **Concept Questions** Each resistor in the three circuits in the drawing has the same resistance R, and the batteries have the same voltage V. (a) How is the total power delivered by the battery related to the equivalent resistance connected between the battery terminals and to the battery voltage? (b) Rank the equivalent resistances of the circuits in descending order (largest first). (c) Rank the three values of the total power delivered by the batteries in descending order (largest first).

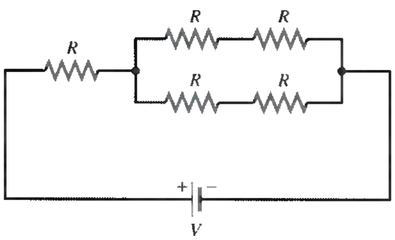
Problem The values for R and V in the drawing are 9.0 Ω and 6.0 V, respectively. Determine the total power delivered by the battery in each of the three circuits. Be sure that your answer is consistent with your answer to Concept Question (c).



Circuit A



Circuit B



Circuit C