18.1 Resistances in Series, Parallel, and Series–Parallel Combinations

1. **MC** Which of the following quantities must be the same for resistors in series? (a) voltage, (b) current, (c) power, (d) energy. (b)

2. **MC** Which of the following quantities must be the same for resistors in parallel? (a) voltage, (b) current, (c) power, (d) energy. (a)

3. **MC** Two resistors (A and B) are connected in series to a 12-V battery. Resistor A has 9 V across it. Which resistor has the least resistance? (a) A, (b) B, (c) both have the same, (d) can't tell from the data given. (b)

4. **MC** Two resistors (A and B) are connected in parallel to a 12-V battery. Resistor A has 2.0 A in it and the total current in the battery is 3.0 A. Which resistor has the most resistance? (a) A, (b) B, (c) both have the same, (d) can't tell from the data given. (b)

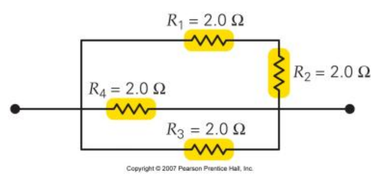
5. **MC** Two resistors (one with a resistance of $2.0\ \Omega$ and the other with $6.0\ \Omega$ resistance) are connected in parallel to a battery. Which one produces the most joule heating? (a) $2.0\ \Omega$, (b) $6.0\ \Omega$, (c) both produce the same, (d) can't tell from the data given. (a)

6. **MC** Two lightbulbs (bulb A has a rating of 100 W *at 120 V* and B has a rating of 60 W *at 120 V*) are connected in series to a wall socket at 120 V. Which one produces the most light? (a) A, (b) B, (c) both produce the same, (d) can't tell from the data given. (b)

7. **CQ** Are the voltage drops across resistors in series generally the same? If not, under what circumstance(s) could they be the same? no; only if all resistances are equal

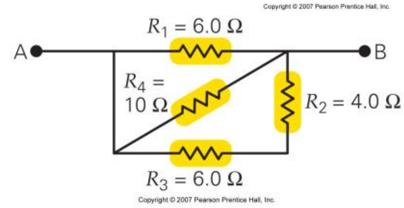
8. **CQ** Are the currents in resistors in parallel generally the same? If not, under what circumstance(s) could they be the same? no; only if all resistances are equal

16. **IE** ● (a) In how many different ways can three $4.0\text{-}\Omega$ resistors, be wired: (1) three, (2) five, or (3) seven? (b) Sketch the different ways you found in part (a) and determine the equivalent resistance for each. (a) (3) seven (b) $1.3\ \Omega$, $2.0\ \Omega$, $2.7\ \Omega$, $4.0\ \Omega$, $6.0\ \Omega$, $8.0\ \Omega$, and $12\ \Omega$; see solutions

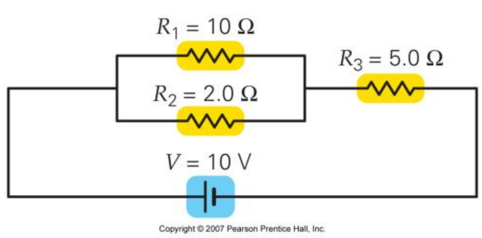


26. ●● What is the equivalent resistance of the resistors in >Fig. 18.25? $0.80\ \Omega$

27. ●● What is the equivalent resistance between points A and B in >Fig. 18.26? $2.7\ \Omega$



28. ●● What is the equivalent resistance of the arrangement of resistors shown in ▾ Fig. 18.27? $7.5\ \Omega$



36. ●●● The terminals of a 6.0-V battery are connected to points A and B in Fig. 18.26 ^. (a) How much current is in each resistor? (b) How much power is delivered to each? (c) Compare the sum of the individual powers with the power delivered to the equivalent resistance for the circuit. see solutions

18.2 Multiloop Circuits and Kirchhoff's Rules

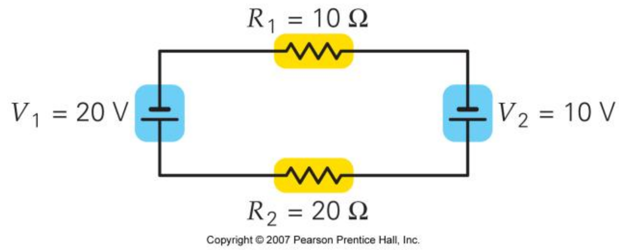
43. **MC** You have a multiloop circuit with one battery. After leaving the battery, the current encounters a junction into two wires. One wire carries 1.5 A and the other 1.0 A. What is the current in the battery? (a) 2.5 A, (b) 1.5 A, (c) 1.0 A, (d) 5.0 A, (e) can't be determined from the given data. (a)

44. **MC** By our sign convention, if a resistor is traversed in the actual direction of the current in it, what can you say about the sign of the change in electric potential (the voltage): (a) it is negative, (b) it is positive, (c) it is zero, or (d) you can't tell from the data given? (a)

45. **MC** By our sign convention, if a battery is traversed in the actual direction of the current in it, what can you say about the sign of the change in electric potential (the battery's terminal voltage): (a) It is negative, (b) it is positive, (c) it is zero, or (d) you can't tell from the data given. (d)

46. **MC** You have a multiloop circuit with one battery that has a terminal voltage of 12 V. After leaving the positive terminal of the battery, a short wire takes you to a junction where the current splits into three wires. From that point until you return to the negative terminal of the battery, what can you say about the sum of the voltages in each wire: (a) they total $+12$ V, (b) they total -12 V, (c) their magnitude is less than 12 V, or (d) their magnitude is greater than 12 V. (b)

55. ●● Using Kirchhoff's rules, find the current in each resistor in >Fig. 18.35. $I_1 = 0.33$ A (left); $I_2 = 0.33$ A (right)



18.3 RC Circuits

60. **MC** As a capacitor discharges through a resistor, the voltage across the resistor is a maximum (a) at the beginning of the process, (b) near the middle of the process, (c) at the end of the process, (d) after one time constant. (a)

61. **MC** When a capacitor discharges through a resistor, the current in the circuit is a minimum (a) at the beginning of the process, (b) near the middle of the process, (c) at the end of the process, (d) after one time constant. (c)

62. **MC** A charged capacitor discharges through a resistor (call this #1). If the value of the resistor is then doubled and the identical capacitor allowed to discharge again (call this #2), how do the time constants compare? (a) $\tau_1 = 2\tau_2$, (b) $\tau_1 = \tau_2$, (c) $\tau_1 = \frac{1}{2}\tau_2$, (d) $\tau_2 = 4\tau_1$. (c)

63. **MC** A capacitor discharges through a resistor (call this #1). The capacitor is then recharged to twice the initial charge in #1, and the discharge occurs through the same resistor (call this #2). How do the time constants compare? (a) $\tau_1 = 2\tau_2$, (b) $\tau_1 = \tau_2$, (c) $\tau_1 = \frac{1}{2}\tau_2$, (d) can't tell from the data given. (b)

71. ●● A 1.00-μF capacitor, initially charged to 12 V, discharges when it is connected in series with a resistor. (a) What resistance is necessary to cause the capacitor to have only 37% of its initial charge 1.50 s after starting? (b) What is the voltage across the capacitor at $t = 3\tau$ if the capacitor is instead *charged* by the same battery through the same resistor? (a) 1.50 MΩ (b) 11.4 V

18.4 Ammeters and Voltmeters

76. **MC** To accurately measure the voltage across a 1-kΩ resistor, the voltmeter should have a resistance that is (a) much larger than 1 kΩ, (b) much smaller than 1 kΩ, (c) about the same as 1 kΩ, (d) zero. (a)

77. **MC** To accurately measure the current in a 1-kΩ resistor, the ammeter should have a resistance that is (a) much larger than 1 kΩ, (b) much smaller than 1 kΩ, (c) about the same as 1 kΩ, (d) as large as possible—essentially infinite if possible. (b)

78. **MC** To correctly measure the voltage across a circuit element, a voltmeter should be connected (a) in series with it, (b) in parallel with it, (c) between the high potential side of the element and ground, (d) none of the preceding. (b)

86. ●● An ammeter has a resistance of 1.0 mΩ. Find the current in the ammeter when it is properly connected to a 10-Ω resistor and a 6.0-V source. (Express your answer to five significant figures to show how it differs from 0.60 A.) 0.59994 A

87. ●●A voltmeter has a resistance of 30 kΩ. What is the current in the meter when it is properly connected across a 10-Ω resistor that is hooked to a 6.0-V source? 0.20 mA

18.5 Household Circuits and Electrical Safety

90. **MC** The ground wire in household wiring (a) is a current-carrying wire, (b) is at a voltage of 240 V from one of the "hot" wires, (c) carries no current, (d) none of the preceding. (a)

91. **MC** A dedicated grounding wire (a) is the basis for the polarized plug, (b) is necessary for a circuit breaker, (c) normally carries no current, (d) none of the preceding. (c)

92. **CQ** In terms of electrical safety, explain clearly what is wrong with the circuit in ▸Fig. 18.40, and why? the fuse and switch are on the ground side of the circuit

93. **CQ** The severity of bodily injury from electrocution depends on the magnitude of the current and its path, yet you commonly see signs that warn "Danger: High Voltage" (▼ Fig. 18.41). Shouldn't such signs be changed to refer to high current? Explain. no, high voltage could produce harmful current even if resistance is high

94. **CQ** Explain why it is perfectly safe for birds to perch with both feet on the same high-voltage wire, even if the insulation is worn through. the voltage between the feet is small

107. A $10.0\text{-}\mu\text{F}$ capacitor in a heart defibrillator unit is charged fully by a $10\,000\text{-V}$ power supply. Each capacitor plate is connected to the chest of a patient by wires and flat "paddles," one on either side of the heart. The energy stored in the capacitor is delivered through an RC circuit, where *R* is the resistance of the body between the two paddles. Data indicates that it takes 75.1 ms for the voltage to drop to 20.0 V. (a) Find the time constant. (b) Determine the resistance, *R*. (c) How much time does it take for the capacitor to lose 90% of its stored energy? (a) 12.1 ms (b) 1.21 kΩ (c) 13.9 ms