Electric Circuits Review

3.1 Electric Circuits

Be able to:

- define current
- solve problems for current, charge, and time
- relate conventional current direction to the electron flow in a conductor
- solve problems involving Ohm's law
- describe the factors that affect the resistance of a material
- solve resistivity problems
- calculate the power dissipated in a load
- draw schematics of simple circuits
- construct simple circuits from schematic diagrams
- demonstrate the correct placement of ammeters and voltmeters in simple circuits
- calculate equivalent resistance for series, parallel, and combined networks
- calculate the resistance, current, voltage, and power for series, parallel, and combined networks

Problems

1. Define electric current.

2. A portable compact disc player is designed to play for 2 hours on a fully charged battery pack. If the battery pack provides a total of 180 C of charge, how much current does the player use in operating? (0.025 A)

3. A CD-ROM drive in a laptop computer uses a current of 0.27 A. In one minute, how many electrons pass through the device? (1.01×10^{20})

4. A toaster has a resistance of 14 Ω and is plugged into a 120 V outlet. What is the current in the toaster? (8.57 A)

5. A battery charger is connected to a dead battery and delivers a current of 6 A for 5 hours, keeping the voltage across the battery terminals at 12 V in the process. How much energy is delivered to the battery? (1296000 J)

6. The resistance of a bagel toaster is 14 Ω. To prepare a bagel, the toaster is operated for one minute from a 120 V outlet. How much energy is delivered to the toaster?
(61714 J)

7. Explain the difference between conventional current direction and the direction of electron flow in a conductor.

8. Identify four factors affecting the resistance of a material. Explain how each affects the resistance.

9. High voltage power lines are a familiar sight throughout the country. The aluminum wire used for some of these lines has a cross sectional area of 4.9×10^{-4} m^2. What is the resistance of ten kilometers of this wire? (0.54 Ω)

10. The filament in an incandescent light bulb is made from tungsten. The radius of the tungsten wire is 0.045 mm. If the bulb is to be plugged into a 120 V outlet and is to draw a current of 1.24 A, how long must the wire be? (10.9 m)

11. Two conducting wires of the same material are to have the same resistance. One wire is 20 m long and 0.40 mm in diameter. If the other wire is 0.30 mm in diameter, how long should it be? (11.25 m)

12. Two cylindrical bars, each with a diameter of 2.30 cm, are welded together end to end. One of the original bars is copper and is 0.470 m long. The other bar is iron and is 0.125 m long. What is the resistance between the ends of the two bars?
(4.87×10^{-5} Ω)

13. Draw a schematic that consists of:
    - three $1.5\ V$ cells connected in parallel
    - a switch
    - two light bulbs connected in series
    - two light bulbs connected in parallel
    - a voltmeter to measure the voltage drop across one of the light bulbs
    - an ammeter to measure the current provided by the battery

14. Draw a schematic that consists of:
    - a $6.0\ V$ source
    - a switch
    - two lamps in series, in parallel with a single lamp
    - an ammeter to measure the current through one of the lamps in parallel
    - a voltmeter to measure the voltage drop across all three lamps

15. Three resistors, 50, 90, and $150\ \Omega$, are connected in series, and a $1.02\ A$ current passes through them. What is

    a) the equivalent resistance? ($290\ \Omega$)

    b) the potential difference across the three resistors? ($295.8\ V$)

16. A $45\ \Omega$ resistor and an $18\ \Omega$ resistor are connected in series across a $12\ V$ battery. What is the voltage across

    a) the $45\ \Omega$ resistor? ($8.57\ V$)

    b) the $18\ \Omega$ resistor? ($3.43\ V$)

17. The current in a series circuit is $24.0\ A$. When an additional $12\ \Omega$ resistor is inserted in series, the current drops to $18.0\ A$. What is the resistance of the original circuit? ($36\ \Omega$)

18. A $4\ \Omega$ loudspeaker and an $8\ \Omega$ loudspeaker are connected in parallel across the terminals of an amplifier. Assuming the speakers behave as resistors, determine the equivalent resistance of the two speakers. ($2.67\ \Omega$)

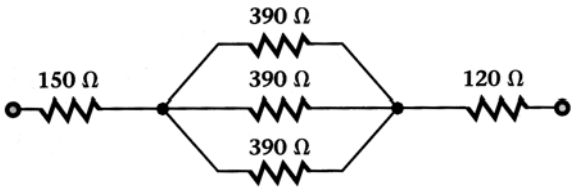
19. Two resistors, 42 and $64\ \Omega$ are connected in parallel. The current through the $64\ \Omega$ resistor is $3.00\ A$.

    a) Determine the current in the other resistor. ($4.57\ A$)

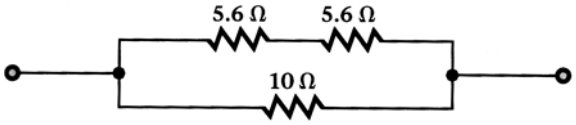
    b) What is the total power consumed by the two resistors? ($1454\ W$)

20. Three resistors of 100, 47, and $33\ \Omega$ are joined together in parallel. What is the equivalent resistance? ($16.2\ \Omega$)

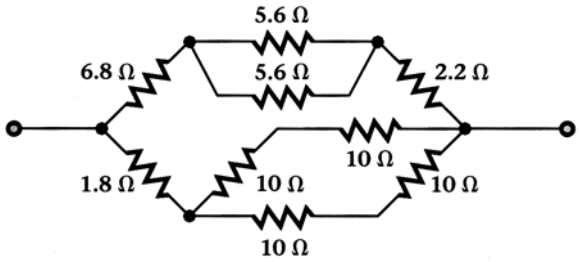
21. Find the equivalent resistance of the network shown below. ($400\ \Omega$)



22. Find the equivalent resistance of the network shown below. ($5.3\ \Omega$)



23. Find the equivalent resistance of the network shown below. ($5.9\ \Omega$)



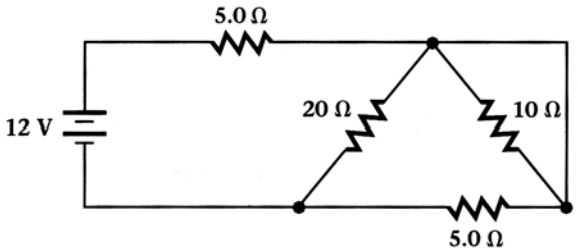
24. An elevator in a 20-story building is used to raise a $7200\ N$ load $50\ m$. How much will it cost to raise the load if electricity costs $\$0.078 / kWh$? Assume that the elevator system is 50% efficient – that is, that the energy expended in raising the load is half of the total energy consumed. (1.6 cents)

25. A $1500\ \Omega$ resistor is rated at $2.0\ W$ maximum power capacity.

    a) What is the maximum voltage that can be applied across the resistor without exceeding its maximum power rating? ($55\ V$)

    b) What is the maximum current? ($0.037\ A$)

26. What is the current through (a) the $10\ \Omega$ resistor and (b) the $20\ \Omega$ resistor in the diagram below? ($0\ A$, $0.27\ A$)



27. Two resistors are connected in series across an ideal $12.0\ V$ battery. Resistor *A* has a value of $24.0\ \Omega$ and the potential difference across resistor *B* is $3.60\ V$.

    a) What is the potential difference across *A*? ($8.4\ V$)

    b) What is the current in the resistors? ($0.35\ A$)

    c) What is the resistance of *B*? ($10.3\ \Omega$)

    d) What is the total power dissipated in the circuit? ($4.2\ W$)

28. Three resistors are joined together across a $24.0\ V$ battery, as shown below. The voltage drop across resistor R_1 is $8.0\ V$, the current through resistor R_2 is $0.20\ A$, and the power dissipated in resistor R_3 is $2.56\ W$.

    a) What is the value of each resistor? ($R_1 = 22.2\ \Omega,\ R_2 = 80\ \Omega,\ R_3 = 100\ \Omega$)

    b) What is the current through each resistor? ($I_1 = 0.36\ A,\ I_2 = 0.2\ A,\ I_3 = 0.16\ A$)

    c) What is the power dissipated in each resistor? ($P_1 = 2.88\ W,\ P_2 = 3.2\ W,\ P_3 = 2.56\ W$)

    d) Find the total resistance of the network. ($66.7\ \Omega$)

    e) Find the current drawn from the battery. ($0.36\ A$)

    f) Find the total power used by the circuit. ($8.64\ W$)