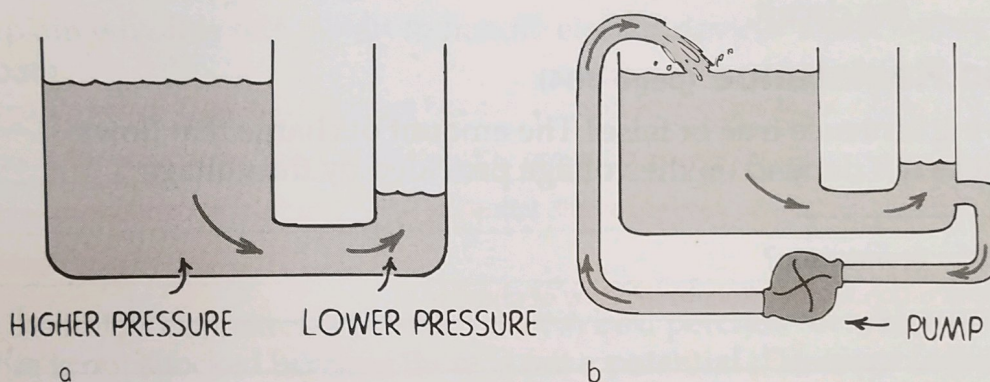


Chapter 34 Electric Current

Exercises

34.1 Flow of Charge (page 681)

- Charge flows when there is a potential difference between the ends of a conductor.
- Explain what would happen if a Van de Graaff generator charged to a high potential was connected to a ground wire.
A surge of charge would flow through the wire. The flow would be brief because the sphere of the generator would quickly reach a common potential with the ground.
- Explain how the sustained flow of charge is analogous to the flow of water from a higher reservoir to a lower one, as shown in the illustration below.



Water will flow in a pipe that connects the reservoirs only as long as a difference in water level exists, as shown in a. The flow of water in the pipe, like the flow of charge in the wire that connects the Van de Graaff generator to the ground, will cease when the pressures at the two ends are equal. For the flow to be sustained, there must be a suitable pump of some sort to maintain a difference in water levels, as shown in b. Then there will be a continual difference in water pressures and a continual flow of water. The same is true of electric current.

34.2 Electric Current (page 682)

Match each phrase with the correct term or terms. Terms may be used more than once.

Phrase	Terms
<u> d </u> 4. the flow of electric charge	a. ampere
<u> c </u> 5. particles within a solid conductor that carry charge through a circuit	b. zero
<u> a </u> 6. SI unit used to measure electric current	c. conduction electrons
<u> a </u> 7. equivalent to 1 coulomb of charge per second	d. electric current
<u> b </u> 8. the net charge in a current-carrying wire	

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34.3 Voltage Sources (page 683)

9. What is a voltage source? something that provides a potential difference
-
10. How do batteries and generators supply electrical energy?
In a battery, chemical reactions occurring inside release electrical energy. In a generator, mechanical energy is converted to electrical energy.
-
11. Is the following sentence true or false? The potential energy per coulomb of charge available to electrons moving between the terminals of a battery or generator is the voltage. true
12. Charges flow through a circuit because of an applied voltage across the circuit.

34.4 Electric Resistance (page 684)

13. Is the following sentence true or false? The amount of charge that flows in a circuit does not depend on the voltage provided by the voltage source. false
14. What is electric resistance?
the resistance that a conductor offers to the flow of charge
-
15. Circle the letter of each statement that is true.
- a. The resistance of a wire depends on the conductivity of the material used in the wire.
 - b. The resistance of a wire does not depend on the thickness of the wire.
 - c. Longer wires have less resistance than short wires.
 - d. Electric resistance depends on the temperature of the wire.
16. The resistance of some materials becomes zero at very low temperatures, a phenomenon known as superconductivity.
17. Electric resistance is measured in units called ohms.

34.5 Ohm's Law (page 685)

18. The relationship among current, voltage, and resistance is called Ohm's law.
19. State Ohm's law.
The current in a circuit is directly proportional to the voltage impressed across the circuit, and is inversely proportional to the resistance of the circuit.
-
20. How can you express Ohm's law mathematically?
current = $\frac{\text{voltage}}{\text{resistance}}$
-

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21. What is the relationship among the units of measurement for the three quantities related by Ohm's law?

$$1 \text{ ampere} = 1 \frac{\text{volt}}{\text{ohm}}$$

22. What are resistors?

Resistors are elements in a circuit that are used to regulate current.

34.6 Ohm's Law and Electric Shock (pages 686–688)

23. The damaging effects of electric shock are the result of _____ **current** _____ passing through the body.

24. Is the following sentence true or false? The resistance of your body is much greater when you're soaked with water than when your skin is dry. _____ **false** _____

25. Explain why it is dangerous to handle electric devices while taking a bath.

If you are standing barefoot in a wet bathtub connected through its plumbing to the ground, the resistance between you and the ground is very small. Your overall resistance is lowered so much that the 120-volt potential difference may produce a harmful current through your body.

26. Is the following sentence true or false? A bird perched on a high-voltage wire is not shocked because there is not a potential difference between one part of its body and another part. _____ **true** _____

27. What is the purpose of the third prong on a three-prong electric plug?

The third prong is connected to the ground to prevent electric shock.

34.7 Direct Current and Alternating Current (pages 688–689)

28. Circle the letter of each statement that is true.

- a. Direct current refers to a charge that always flows in one direction.
- b. In a DC circuit, electrons always move from the positive terminal toward the negative terminal.
- c. A battery produces direct current.
- d. AC is current that repeatedly reverses direction.

29. Circle the letter of the correct answer. A 60-hertz current means that the current

- a. equals 60 amperes.
- b. alternates back and forth at 60 cycles per second.
- c. changes direction once every 60 seconds.
- d. travels at a speed of 60 meters per second.

30. Circle the letter of the correct answer. What is the standard voltage of AC in the United States?

- a. 9 V
- b. 12 V
- c. 110–120 V
- d. 220–240 V

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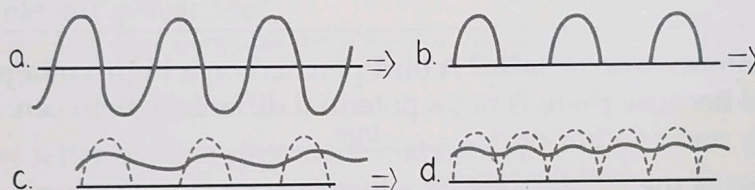
31. Will an appliance that operates on 220–240 volts work when plugged into a wall socket in the United States? Explain your answer.

Yes. Appliances that operate on 240 volts (such as electric stoves, air conditioners, and clothes dryers) can operate on a 120-volt AC line because most U.S. electric service is three-wire: one wire at 120 volts positive, one wire at zero volts (neutral), and one wire at a negative 120 volts. When the plus-120 wire is connected to the minus-120 wire, a 240-volt jolt is produced.

34.8 Converting AC to DC (page 690)

32. The current in laptops and cell phones is DC.
33. With an AC-DC converter, you can operate a battery-run device on AC instead of batteries.
34. In addition to a transformer to lower the voltage, an AC-DC converter uses a diode, which acts as a one-way valve to allow electron flow in only one direction.

The diagrams below show the effect of an AC–DC converter on alternating current. Match the letter of each diagram to the correct description.



- c 35. Charging and discharging of a capacitor provides continuous but bumpy current.
- b 36. Only half of each cycle of AC passes through the diode, resulting in a pulsating DC.
- a 37. The input to the diode is AC.
- d 38. By using a pair of diodes, there are no gaps in the current output.

34.9 The Speed of Electrons in a Circuit (pages 691–692)

39. Circle the letter of each statement that is true.

- a. Energy is transported through connecting wires of a circuit at nearly the speed of light.
- b. The electrons that make up an electric current travel at the speed of light.
- c. The electric field inside a current-carrying wire has no effect on the motion of conduction electrons.
- d. The random thermal motion of the electrons inside a wire is what produces current.

40. Is the following statement true or false? A pulsating electric field can travel through a circuit at nearly the speed of light. true

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41. Explain why current-carrying wires become hot.

Conduction electrons are accelerated by the electric field. Before the electrons can gain appreciable speed, they "bump into" the anchored metallic ions in their paths and transfer some of their kinetic energy to them. This causes the current-carrying wires to become hot.

42. In a current-carrying wire, collisions interrupt the motion of the electrons so that their actual drift speed, or net speed through the wire due to the field, is extremely low.

43. In an AC circuit, do the conduction electrons make any net progress in a single direction? Explain your answer.

No; in a single cycle the electrons drift a tiny fraction of a centimeter in one direction, and then the same tiny distance in the opposite direction.

34.10 The Source of Electrons in a Circuit (page 693)

44. The source of electrons in a circuit is the

conducting circuit material itself

45. When you plug a lamp into an AC outlet, energy flows from the outlet into the lamp, not electrons.

46. If 120 volts AC are impressed on a lamp, then an average of 120 joules of energy are dissipated by each coulomb of charge that is made to vibrate.

47. When you turn on an electric lamp, what two forms of energy are produced? heat and light

48. Explain what happens in your body when you are jolted by an AC electric shock.

When you are jolted by an AC electric shock, electrons do not come out of the wire and through your body and into the ground; energy does. The energy simply causes free electrons in your body to vibrate in unison.

34.11 Electric Power (pages 693–694)

49. Define electric power.

Electric power is the rate at which electrical energy is converted into another form such as mechanical energy, heat, or light.

50. Electric power = current \times voltage

51. Express the equation in Question 50 in terms of units.

1 watt = 1 ampere \times 1 volt

52. One kilowatt-hour is the amount of energy consumed in 1 hour at the rate of 1000 watts.

53. If the power and voltage on a lightbulb read "60 W, 120 V," how much current will flow through the bulb?

$$I = \frac{P}{V} = \frac{60 \text{ W}}{120 \text{ V}} = 0.5 \text{ A}$$

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Calculating Power

If four 1.5-V batteries deliver 1.25-A current to a small motor, what is the power provided to the motor?

1. Read and Understand

What information are you given?

$$\text{voltage} = V = 4 \times 1.5 \text{ V} = 6.0 \text{ V}$$

$$\text{current} = I = 1.25 \text{ A}$$

2. Plan and Solve

What unknown are you trying to calculate?

$$\text{power} = P = ?$$

What mathematical expression can you use to calculate the unknown?

$$P = VI$$

$$P = (6.0 \text{ V})(1.25 \text{ A}) = 7.5 \text{ W}$$

3. Look Back and Check

Is your answer reasonable?

Yes, the number calculated is a product of current and voltage and the units indicate power.

Math Practice

On a separate sheet of paper, solve the following problems.

1. An 8.0-V power supply delivers a 1.75-A current to a circuit. Calculate the power provided to the circuit.

$$P = VI = (8.0 \text{ V})(1.75 \text{ A}) = 14 \text{ W}$$

2. How much power is used by a set of lights operating on a 12-V battery and 2.75 A?

$$P = VI = (12 \text{ V})(2.75 \text{ A}) = 33 \text{ W}$$

3. A 15-W motor draws a current of 1.25 A. What is the voltage impressed across the circuit?

$$V = \frac{P}{I} = \frac{15 \text{ W}}{1.25 \text{ A}} = 12 \text{ V}$$