Chapter 13 Answer Key

13.1 Section Review

1. The current is the same at any point in a series circuit.
2. There is only one path for current in a series circuit. When the switch is opened, the current stops throughout the circuit and all three bulbs will go out.
3. The total resistance for a series circuit increases as each resistor is added.
4. Since the bulbs have the same resistance, the voltage drop would be the same across each bulb. The voltage drop would be one-third of the total voltage, or 3V.

13.2 Section Review

1. The voltage is the same across each branch of a parallel circuit. Each device is connected back to the power source (battery) by wires without any other electrical devices in the way.
2. The current in each branch is determined by the branch resistance and Ohm's law. The total current in a parallel circuit is the sum of the currents in each branch.
3. Home electrical systems use parallel wiring because each device can be turned on and off independently of the others devices.
4. The total current in a parallel circuit increases as more branches are added. The total current is the sum of the currents in each branch. The only time branches have an effect on each other is when the total current is more than the battery or wall outlet can supply.
5. For two resistors:

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{12\ \Omega \times 12\ \Omega}{12\ \Omega + 12\ \Omega} = 12\ \Omega$$

For three resistors:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{12\ \Omega} + \frac{1}{12\ \Omega} + \frac{1}{12\ \Omega} = 4\ \Omega$$

13.3 Section Review

1. Electrical power is the rate at which electrical energy is converted into other forms of energy. The power of an appliance is measured in watts, or joules, of energy used per second. A 100-watt appliance uses (or converts) 100 joules of energy every second.
2. One horsepower is 746 watts (or 746 joules each second). One kilowatt is 1000 watts (or 1000 joules each second). One kilowatt-hour means that a kilowatt of power has been used for one hour. A kilowatt-hour is a unit of energy equal to 3.6 million joules.
3. The utility company charges you for energy measured in kilowatt-hours.
4. Direct current: the current is always in the same direction. Alternating current: the current constantly switches direction.

Connection Answers

1. A person who does mostly city driving would derive the greater benefit from a gas-electric hybrid. Gas-electric hybrid engines shut off at stoplights. Gas-electric hybrid vehicles use only the electric motor at low speeds. These features benefit the city driver, but are not used during highway driving.
2. Answers will vary.
3. Answers will vary.

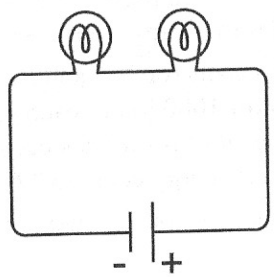
Understanding Vocabulary

1. series circuit
2. voltage drop
3. Kirchhoff's current law
4. parallel circuit
5. kilowatt-hour
6. alternating

Reviewing Concepts

Section 13.1

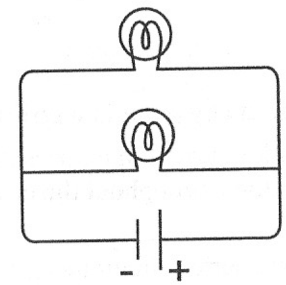
1.



2. The current is the same at every point.
3. If bulbs are wired in series, when the circuit is opened, such as when a bulb burns out, the current stops flowing everywhere in the circuit and ALL the bulbs go out.
4. The total resistance in a series circuit is the sum of the resistances in the circuit.
5. As more bulbs are added, the total resistance in a series circuit increases and the brightness of the bulbs decreases.
6. Kirchhoff's voltage law is an application of the law of conservation of energy. The power used by the bulbs in the circuit is equal to the power supplied by the battery. The sum of the voltage drops across the bulbs is the same as the voltage of the battery.

Section 13.2

7. A parallel circuit is a circuit with more than one path over which the current may flow.
8.



9. The current entering a point in a circuit is equal to the current flowing out of the point.
10. voltage
11. Each device in the circuit has the same voltage drop as the voltage source and each device in the circuit may be turned off independently without stopping the current in the other devices in the circuit.
12. Appliances in a home are connected together in parallel circuits. If one appliance is turned off, the others will still operate.
13. The total resistance decreases. There are more paths for the current to follow and more current flows for the same voltage drop.
14. $R_T = \dfrac{R_1 \times R_2}{R_1 + R_2}$
15. The reciprocal of the total resistance is the sum of the reciprocals of the individual resistances.
16. A short circuit is a parallel path in which there is little resistance. Short circuits allow large currents to flow which can generate enough heat in a wire to melt the wire or start a fire.

Section 13.3

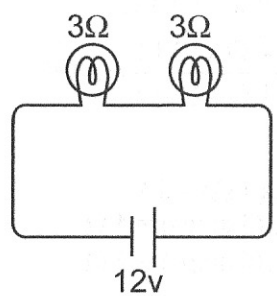
17. 60 joules of energy is used in the light bulb every second.
18. To calculate the power of an appliance, multiply current flowing through the appliance by the voltage drop across the appliance. $P = IV$

19. The kilowatt-hour is a measure of the energy. One kilowatt of power has been used for one hour.
20. Direct current is current that flows in one direction while alternating current switches direction constantly.
21. Alternating current used in the United States reverses direction 60 times each second.s
22. Thinner wires have more resistance than thicker wires.
23. Longer wires have more resistance than shorter wires.
24. Too long wires will cause a voltage drop and appliances may not work properly.

Solving Problems

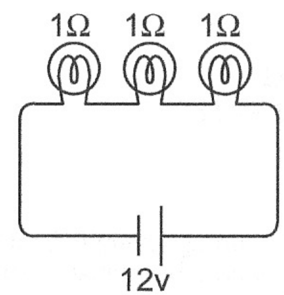
Section 13.1

1. $R_t = R_1 + R_2 + R_3 = 5\ \Omega + 3\ \Omega + 8\ \Omega$
   $R_t = 16\ \Omega$
2. $V_t = V_1 + V_2;\ V_1 = V_2$
   $V_t = 2V_1$
   9 volts $= 2V_1$
   $V_1 = 4.5$ volts
3.



$R_t = R_1 + R_2 = 3\ \Omega + 3\ \Omega$
$R_t = 6\ \Omega$
Since the current is the same everywhere in a series circuit:
$I_t = V_t/R_t$
$I_t = (12\ \text{V})/(6\ \Omega)$
$I_t = 2$ amps
$V_t = V_1 + V_2;\ V_1 = V_2$
12 volts $= 2V_1$
$V = 6$ volts

4.



$R_t = R_1 + R_2 + R_3 = 1\ \Omega + 1\ \Omega + 1\ \Omega$
$R_t = 3\ \Omega$
$I_t = V_t/R_t$
$I_t = (12\ \text{V})/(3\ \Omega)$
$I_t = 4$ amps

5. Answers are:
   a. $R_t = R_1 + R_2 = 1\ \Omega + 1\ \Omega$
      $R_t = 2\ \Omega$
      $I_t = V_t/R_t$
      $I_t = (6\ \text{V})/(2\ \Omega)$
      $I_t = 3$ amps
   b. $R_t = R_1 + R_2 = 3\ \Omega + 3\ \Omega$
      $R_t = 6\ \Omega$
      $I_t = V_t/R_t$
      $I_t = (6\ \text{V})/(6\ \Omega)$
      $I_t = 1$ amps
   c. $R_t = R_1 + R_2 + R_3 = 1\ \Omega + 2\ \Omega + 3\ \Omega$
      $R_t = 6\ \Omega$
      $I_t = V_t/R_t$
      $I_t = (12\ \text{V})/(6\ \Omega)$

$I_t = 2$ amps

6. $R_t = R_1 + R_2 = 1\ \Omega + 1\ \Omega$
   $R_t = 2\ \Omega$
   $V = I_t R_t$
   $V = (1.5\ A)(2\ \Omega)$
   $V = 3$ volts

7. $R_t = V/I$
   $R_t = (24\ V)/(3\ A) = 8\ \Omega$
   $R_1 = R_2 = R_t/2 = 8\ \Omega/2 = 4\ \Omega$

Section 13.2

8. Answers are:
   a. 2 amps are flowing through point P from left to right. The current flowing from the source is 4 amps. 2 amps are flowing through the upper branch of the circuit and 2 amps flows through the center branch of the circuit.
   b. 4 amps flowing through point P from bottom to top. The sum of the current in the branches is 4 amps.
   c. 2 amps are flowing through point P from left to right. The sum of the current flowing back to the source is 3 amps, 1 amp from the upper branch and 2 amps from the lower branch.

9. For each of the circuits:
   a. The voltage is equal to the voltage of the source.
   b. $I = V/R$ for each resistor
   c. $I_t = I_1 + I_2$
   d. $R_t = V_t/I_t$

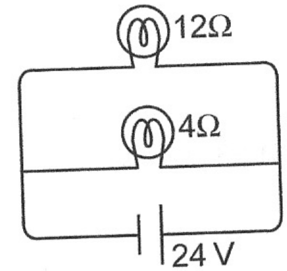
A	B	C
$V = 12$ V	$V = 24$ V	$V = 24$ V
$I = 6$ amps in each	$I = 6$ amps in each	$I_{(6\Omega)} = 4$ amps $I_{(12\Omega)} = 2$ amps
$I_t = 12$ amps	$I_t = 12$ amps	$I_t = 6$ amps
$R_t = 1\ \Omega$	$R_t = 2\ \Omega$	$R_t = 4\ \Omega$

10. Answers are:
   a. TG_RQA 6 ohm parallel
   b. $I = V/R = (6\ V)/(6\ \Omega) = 1$ amp in each
   c. $I_t = I_1 + I_2 = 1$ amp $+ 1$ amp $= 2$ amps
   d. $R_t = V_t/I_t = (6\ V)/(2\ A) = 3\ \Omega$

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{6\ \Omega \times 6\ \Omega}{6\ \Omega + 6\ \Omega} = 3\ \Omega$$

   e.

11. Answers are:
   a.



   b. $I_4 = V/R_4 = (24\ V)/(4\ \Omega) = 6$ amps
   $I_{12} = V/R_{12} = (24\ V)/(12\ \Omega) = 2$ amps
   c. $I_t = I_4 + I_{12} = 6$ amps $+ 2$ amps $= 8$ amps
   d. $R_t = V_t/I_t = (24\ V)/(8\ A) = 3\ \Omega$

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{4\ \Omega \times 12\ \Omega}{4\ \Omega + 12\ \Omega} = 3\ \Omega$$

   e.

12. Answers are:
   a. $V = IR = (2\ \text{amps})(4\ \Omega) = 8$ V
   b. $R_1 = V/I = (12\ V)/(3\ \text{amps}) = 4\ \Omega$
   c. $R_2 = V/I = (12\ V)/(6\ \text{amps}) = 2\ \Omega$
   $I_t = I_1 + I_2$
   $12\ A = 4\ A + I_2$
   $I_2 = 8$ A
   $R = V/I = (24\ V)/(4\ A) = 6\ \Omega$

Section 13.3

13. Answers are:
    a. $P = IV = (10 \text{ amps})(120 \text{ V}) = 1{,}200$ watts
    b. $P = IV = (2 \text{ amps})(120 \text{ V}) = 240$ watts
    c. $P = IV = (0.5 \text{ amps})(120 \text{ V}) = 60$ watts
14. Answers are:
    a. $I = P/V = (100 \text{ W})/(120 \text{ V}) = 0.83$ amps
    b. $I = P/V = (1{,}200 \text{ W})/(120 \text{ V}) = 10$ amps
    c. $I = P/V = (30 \text{ W})/(120 \text{ V}) = 0.25$ amps
15. $V = P/I = (15 \text{ W})/(1.5 \text{ amps}) = 10$ V
16. The 1.5 V cells will be connected in series so the total voltage required will be divided by 1.5 V to determine the number of 1.5 V cells needed.
    $V_t = P/I = (6 \text{ W})/(2 \text{ amps}) = 3\text{V}$
    # of batteries = V_t / Volts per battery = 2
17. Answers are:
    a. 1,000 W = 1 kW
    b. Energy = Power × Time = 1kW × 8 hours = 8 kW-hr
    c. Total Cost = (cost per kW-hr)(# of kW-hr)
       Total cost = ($0.15/kW-hr)(8 kW-hr) = $1.20
18. Answers are:
    a. 1000 W = 1 kW; 300 w = 0.3 kW
    b. Energy = Power × Time = 0.3 kW × 2 hours = 0.6 kW-hr
    c. Total Cost = (cost per kW-hr)(# of kW-hr)
       Total cost = ($0.15/kW-hr)(0.6 kW-hr) = $0.09 (9 cents)

Test Practice

Section13.1

1. b
2. d
   $I = V/R$
   $I = 12\text{V}/(1\Omega + 2\Omega + 3\Omega) = 2$ amps
3. b
4. c
   $V = IR$
   $V = (1.5 \text{ amps})(2\Omega + 2\Omega + 2\Omega) = 9\text{V}$

Section 13.2

5. d
6. a
7. d
   $I = V/R$
   $I_1 = (12\text{V})/(1\Omega) = 12$ amps
   $I_2 = (12\text{V})/(1\Omega) = 12$ amps
   $I_T = I_1 + I_2 = 24$ amps
8. b
   $1/R_T = 1/R_1 + 1/R_2$
   $1/R_T = 1/6 + 1/3$
   $R_T = 2\ \Omega$

Section 13.3

9. a
   $P = IV$
   $P = (2 \text{ amps})(120\text{V}) = 240$ watts
10. c
11. c
    number of kilowatt hours = (# of kilowatts) × (hours appliance is used)
    number of kilowatt hours = (300 watts) × (1 kW/ 1,000 watts) × (10 hours) = 3 kWh
    cost = (3 kWh) × ($0.15/kWh) = $0.45
12. b
    $I = P/V$
    $I = (2{,}400 \text{ watts})/(120\text{V}) = 20$ amps

Applying Your Knowledge

Section 13.1

1. Answers will vary. Almost any appliance will use series circuits, and parallel circuits as well. A good example of a series circuit is a light

Chapter 14 Answer Key

14.1 Section Review

1. Matter is made up of neutral atoms which have equal amounts of charged electrons and charged protons.
2. The force is one-ninth as strong when the distance is tripled.
3. Because a wall is an insulator, its atoms will become polarized when a negatively charged balloon is near. The positive sides of the wall atoms will move closer to the negative balloon and attract it. Because a doorknob is a conductor, some of the balloon's excess electrons will move onto the doorknob when they touch, giving the doorknob a net negative charge. The negatively charged balloon will repel the negatively charged doorknob.

14.2 Section Review

1. Benjamin Franklin believed electricity was a type of fluid which would flow from positive (or too much fluid) to negative (or too little fluid). His convention of defining current from positive to negative still stands.
2. The electrons do not come from the voltage source. Current flows because an applied voltage makes *all* of the free electrons in the wire move at the same time.
3. The atoms in an insulator are fixed in place. There are no free electrons to carry current.
4. A volt is one joule per coulomb.

14.3 Section Review

1. The parallel plates store energy by keeping positive and negative charges separated.
2. The capacitor will have stored as much energy as it can when the voltage across the capacitor's terminals is the same as the voltage of the battery, or 1.5 volts.
3. The current decreases. The voltage increases.
4. The capacitance is larger. The greater the area of the plates, the more charge the capacitor can hold.
5. A capacitor can discharge very quickly, creating a large amount of current, if connected to a circuit with very low resistance.

Connection Answers

1. Before a lightning strike, the bottom of a cloud acquires an excess negative charge (like feet when scuffed on carpet). The excess negative charge in a cloud is transferred to another object during a lightning strike, as happens in a static shock. Both processes give off light.
2. Electrons in the stepped leader knock other electrons off of air molecules. When these air molecules break apart, you end up with a pathway made up of positive ions surrounded by a sea of electrons (the broken-apart air molecules are known as plasma). The pathway, therefore, is called a "plasma wire."

3. Safety tips from the National Lightning Safety Institute include:

   1. PLAN in advance your evacuation and safety measures. When you first see lightning or hear thunder, activate your emergency plan. Now is the time to go to a building or a vehicle. Lightning often precedes rain, so don't wait for the rain to begin before suspending activities.
   2. IF OUTDOORS...Avoid water. Avoid the high ground. Avoid open spaces. Avoid all metal objects including electric wires, fences, machinery, motors, power tools, etc. Unsafe places include underneath canopies, small picnic or rain shelters, or near trees. Where possible, find shelter in a substantial building or in a fully enclosed metal vehicle such as a car, truck or a van with the windows completely shut. If lightning is striking nearby when you are outside, you should: A. Crouch down. Put feet together. Place hands over ears to minimize hearing damage from thunder. B. Avoid proximity (minimum of 15 ft.) to other people.
   3. IF INDOORS... Avoid water. Stay away from doors and windows. Do not use the telephone. Take off head sets. Turn off, unplug, and stay away from appliances, computers, power tools, & TV sets. Lightning may strike exterior electric and phone lines, inducing shocks to inside equipment.
   4. SUSPEND ACTIVITIES for 30 minutes after the last observed lightning or thunder.
   5. INJURED PERSONS do not carry an electrical charge and can be handled safely. Apply First Aid procedures to a lightning victim if you are qualified to do so. Call 911 or send for help immediately.
   6. KNOW YOUR EMERGENCY TELEPHONE NUMBERS.

Understanding Vocabulary

1. static electricity
2. Coulomb's law
3. electroscope
4. superconductor
5. capacitor
6. farads

Reviewing Concepts

Section 14.1

1. positively; negatively
2. repel; attract
3. An object is electrically neutral when the net charge on the object is zero.
4. positive
5. 6.24×10^{18} protons
6. It is the same size, but opposite in sign.
7. Because most objects are electrically neutral, they exert no net force on one another.
8. The size of the charges and the distance between the charges determines the force between the charges.
9. The force between two charges increases by the square of the decrease in the distance between the charges.
10. Answers are:
    a. The force increases by four times.
    b. The force is one-fourth as strong.
    c. The force is one-ninth as strong.
    d. The force becomes attractive (negative).
    e. The force is identical.
11. The laws are similar in form. The forces in each are inversely proportional to the square of the distance. Replacing the mass in Newton's law with charge in Coulomb's law and replacing Newton's Universal Constant with the electrostatic constant makes the laws interchangeable.
12. The leaves will move apart. Negative charges are attracted to the ball, leaving the leaves positively charged and causing them to move apart by repulsion.
13. The balloon will become negatively charged and your hair will become positively charged. This is called charging by friction.

14. Bring a negatively charged object close to the electroscope. Ground the electroscope. Remove the ground from the electroscope. The electroscope will acquire a positive charge.

Section 14.2

15. Amperes of current measure the number of coulombs of charge that flow past a point in one second.
16. Positive to negative; negative to positive
17. No, only the free electrons.
18. The voltage of the battery causes the electrons that are already in the wire to drift through the wire. The electrons circulate through the entire circuit, including through the battery.
19. The electrons in a conductor are free to move; they are not free to move in an insulator.
20. joule; coulomb; watt; ampere

Section 14.3

21. A capacitor is a device that stores electrical energy. A charged capacitor can create current in a circuit.
22. A capacitor is charged when one of its plates has a positive charge and the other plate has a negative charge.
23. The current in a circuit containing a capacitor decreases to zero as the capacitor charges. The capacitor will stop charging and current will stop flowing when the voltage across the plates of the capacitor equals the voltage of the battery used to charge the capacitor.
24. The amount of charge a capacitor will hold, its capacitance, depends upon three factors: (1) the area of the plates, (2) the insulating material between the plates, and (3) the distance between the plates.

Solving Problems

Section 14.1

1. $$\text{charge} = \frac{1{,}000 \text{ electrons}}{6.24\times10^{18} \text{electrons per coulomb}} = 1.602\times10^{-16}\text{C}$$

2. Answers are:
   a. +2
   b. -1
   c. 0 or neutral

3.
$$F_E = k\frac{q_1 q_2}{r^2} = \left(9\times10^9\ \frac{\text{Nm}^2}{\text{C}^2}\right)\frac{(2.5\times10^{-6}\text{ C})(2.5\times10^{-6}\text{ C})}{(2\text{ m})^2}$$
$$F_E = 1.41\times10^{-2}\text{ N}$$

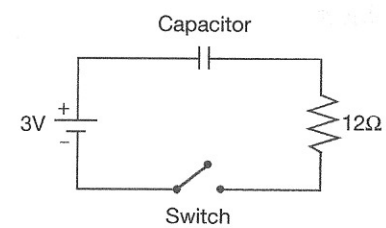
4.
$$F_E = k\frac{q_1 q_2}{r^2}$$
$$9\text{ N} = \left(9\times10^9\ \frac{\text{Nm}^2}{\text{C}^2}\right)\frac{q^2}{(3\text{ m})^2}$$
$$q^2 = 9\times10^{-9}$$
$$q = 9.5\times10^{-5}\text{ C}$$

Section 14.2

5. Current = charge per time
   $I = (6\text{ C})/(2\text{ s}) = 3$ amperes
6. Charge = current × time
   $Q = (2\text{ amps})(10\text{ s}) = 20\text{ C}$

Section 14.3

7.



8. The charge on the second plate is +1 coulomb. Although we call it a "1 coulomb capacitor," the net charge on the whole capacitor is zero.

Chapter 15 Answer Key

15.1 Section Review

1. Just as you cannot have a one-sided coin, each magnet must have a north and south pole.
2. Two north poles repel one another, two south poles repel one another, a north and south pole attract one another.
3. The direction of the magnetic field lines indicate the direction in which the north pole of a compass (or the north pole of a test magnet) will point.
4. Magnetic weather stripping in doors for blocking out drafts.

15.2 Section Review

1. The north pole will be at the head-end of the nail and south pole at the point-end.
2. To increase the strength of the electromagnet, (a) increase the number of turns of wire wrapped around the nail, (b) increase the current flowing through the coils of wire,
3. All magnetism is created by the motion of electric charges. In an electromagnet, the motion of the charges is created by causing a current to flow through a conducting wire. In a permanent magnet, the magnetism is caused by aligned magnetic fields created by the motion of the electrons in the ferromagnetic material.
4. A magnetic field is created in a ferromagnetic material by the alignment of the its magnetic domains creating an overall magnetic field.
5. Permanent magnets are not truly permanent. The magnetism will decrease over time as the magnetic domains become disordered due to shock, vibration, and/or heating of the magnet. Stronger magnets may also be used to demagnetize weaker magnets.

15.3 Section Review

1. The earliest compasses consisted of a piece of naturally occurring magnetic materials called a lodestone. Suspended, the lodestone orients itself in a north-south direction with one end always pointing toward the north.
2. The compass needle aligns itself with the magnetic lines of force, the north end of the compass pointing away from the north pole of the magnet creating the field.
3. Earth's core consists of molten metal slowly circulating a solid inner core. Huge electric currents flowing in the molten metal produce Earth's magnetic field.
4. Earth's magnetic north pole is NOT at the same location as the geographic north pole. It is located about 600 miles south of the geographic north pole.

Connection Answers

1. The main magnet is used to temporarily "polarize" the nuclei of certain atoms in parts of the body. The gradient magnets locate a particular area of the body to be imaged.
2. The unmatched nuclei in the body resonate as the result of the radio waves.
3. MRI pros--does not expose patient to radiation. Takes scans at virtually any angle which can be combined to form three dimensional images. Especially good at identifying soft tissue abnormalities. MRI cons--cannot be used by someone with implanted metal such as a pacemaker or a cochlear implant, most expensive of the three imaging procedures. CAT scan pros--faster than an MRI scan (CAT scans take about 5 minutes, while MRI scans average about 30 minutes). Less expensive than an MRI scan. Cons--exposes patient to radiation that can be harmful in large doses, cannot change the plane of the image without moving the patient. X-ray pros--least expensive, good at identifying abnormalities in bones. X-ray cons--exposes patient to radiation that can be harmful in large doses.

8. Here are some of the precautions taken by MRI imaging centers: Before having an MRI exam, the patient is asked if he/she has had any surgeries, an implanted pacemaker, aneurism clips, metal in eyes, metal implants in ears, and implanted drug infusion device, shrapnel or bullet wounds, or permanent eyeliner. If a patient has ever been a metal worker, he/she will need special x-rays to make sure there are no metal fragments in the eyes. Patients are asked to remove all metallic items (glasses, watches, jewelry, etc). Patients are provided a secure area to leave cards with a magnetic strip (bank cards, parking passes, etc) so that they will not be erased by the MRI magnets.

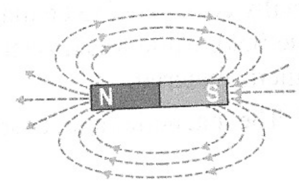
Understanding Vocabulary

1. magnetic declination
2. magnetic field lines
3. diamagnetic
4. compass

Reviewing Concepts

Section 15.1

1. A magnetic material has the ability to exert forces on magnets or other magnetic materials.
2. The magnet is a *permanent magnet* because it retains its magnetic properties after it is removed. The refrigerator door is a *magnetic material* because it does NOT retain its magnetic properties permanently.
3. No. A north pole always occurs together with a south pole just the "heads" of a coin is always accompanied by a "tails".
4. Each half of the magnet becomes a magnet with a north and south pole.
5. repel; repel; attract
6. Yes. Most materials are transparent to magnetic fields.
7. Answers will vary. Examples include: for lifting heavy objects, sealing doors as magnetic weatherstripping, magnetic zippers, and magnetic latches.
8. The region around a magnet is called the magnetic field. It is a force field.
9.



10. north; south
11. The field intensity is indicated by the spacing of the lines. Lines closer together indicate a stronger force per charge, while more widely spaced lines indicate a smaller force per charge.
12. The strength of the magnetic field decreases as you move away from a magnet.

Section 15.2

13. A simple electromagnet is made by wrapping a current-carrying wire around a soft iron core.
14. The iron core concentrates the magnetic field lines, creating a stronger electromagnet.
15. If the fingers of your right hand wrap around the coil of the electromagnet in the direction of the current, your thumb points in the direction of the north pole of the electromagnet.
16. The strength of an electromagnet will increase as the current is increased.
17. The direction of the magnetic field of a magnet will be reversed if the direction of the current is reversed.
18. By increasing the number of turns of wire and wrapping the wire around a more permeable core material.
19. An increase in current can cause a marked increase in the amount of heat dissipated by the coil accompanied by an increase in its resistance.
20. The strength of the magnetic field and its direction can be changed in an electromagnetic.

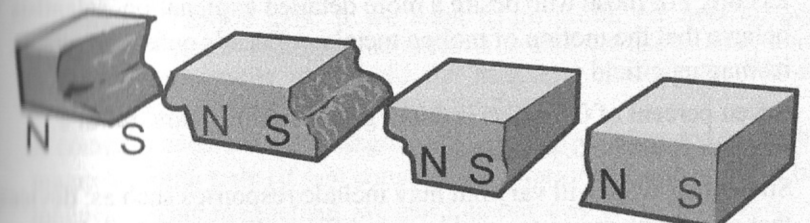
21. Diamagnetic materials will be weakly repelled by a strong magnetic field but are not normally considered to be magnetic.
22. Paramagnetic materials will be weakly attracted by a strong magnetic field but are not normally considered to be magnetic. Their positive response to a magnetic field, while weak, is stronger than the negative response of a diamagnetic material.
23. It is weakly attracted. The magnetic field disappears.
24. Iron, cobalt, nickel
25. Magnetic domains are groups of neighboring atoms whose magnetic fields are similarly aligned.
26. Ferromagnetic materials are more strongly magnetic because groups of atoms become organized very quickly by "adopting" atoms of close-by domains.
27. Rubbing a ferromagnetic material with a permanent magnet causes the ferromagnetic material to become permanently magnetized.
28. Hard magnets retain their magnetic properties for a longer time soft magnets although soft magnets are easier to magnetize. Soft magnets are easier to magnetize but hard magnets retain their magnetism for a longer time.
29. Soft magnets are easier to magnetize and demagnetize.
30. Magnets can be demagnetized by heating them, by strong shocks (dropping or striking the magnets sharply) and by subjecting them to stronger magnetic fields.

Section 15.3

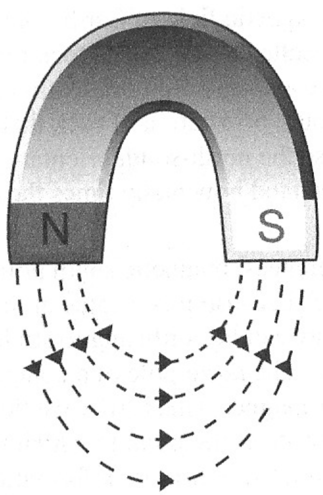
31. The Greeks used natural magnets as compasses to help them to navigate.
32. Answers will vary. Examples include:
    a. The Chinese used a suspended lodestone shaped like a spoon balanced on a plate to indicated direction. The "handle" of the spoon pointed south.
    b. A needle-like compass was floated on a reed in a bowl of water.
    c. Chinese inventors suspended a compass needle in the air to indicate the north-south direction.
33. The end of the magnetic referred to as the north pole should be more correctly called the north seeking pole because it points toward the geographic north pole
34. No. The magnetic north pole is determined by Earth's magnetic field. The north pole of Earth's magnetic field is located near (but not at) the south geographic pole.
35. The north pole of a compass points north because it aligns with the magnetic field of Earth whose south pole is located close to the north geographic pole of Earth. The north pole is attracted by the opposite south pole.
36. Unless you aware of the magnetic declination, you will not be able to adjust for the difference between true north and the (magnetically) indicated north.
37. Earth's magnetic field is more than 600 times weaker than the field at the surface of a small ceramic magnet.
38. Earth's core is made of molten iron, nickel, and other metals slowly circulating around a solid core.
39. Scientists believe huge electric currents flowing in the molten iron produce Earth's magnetic field.
40. Historical data indicate that both the strength of Earth's magnetic field and the location of the north and south poles have changed over time.
41. If the current trend continues, the poles will reverse in about 2000 years.

...lving Problems

...tion 15.1



The field is stronger at A and weaker at C. This is indicated by the distance between the lines of the magnetic field. The field is stronger where lines of the field are closer together.



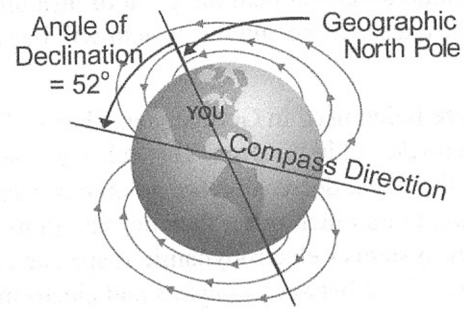
Section 15.2

4. Choice A. Using the right-hand rule, wrapping the right hand around the coil with fingers pointing in the direction of the current, the thumb will point in the direction of the north pole of the coil.

5. The diagram should be labeled with the north pole at the point of the pin and the south pole at the head of the pin.
6. South

Section 15.3

7.



Test Practice

Section 15.1

1. b
2. c
3. b
4. d
5. c

Section 15.2

6. d
7. a
8. b

Section 15.3

9. d
10. a