

Unit 4 Physical Science—Electricity and Magnetism

Answer Key

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4.1.1 Review Questions

1. Protons have a positive charge and neutrons have no charge. Both are in the nucleus of the atom. Electrons occupy energy levels around the nucleus and have a negative charge.
2.
 - a) Diagram should illustrate two positively charged balloons moving away from each other.
 - b) Diagram should illustrate one positively charged balloon and one negatively charged balloon moving toward each other.
 - c) Diagram should illustrate two negatively charged balloons moving away from each other.
3. The sweater, having lost electrons, ends up with a net positive charge. The display case, having gained electrons, ends up with a net negative charge.
4. The friend is incorrect. The balloons have charges, but they are relatively equal in proportion, so there is no net charge on the balloons (neutral).
5. The negatively charged comb has caused the charges in the confetti to separate. The positively charged sides of the confetti are attracted to the comb, making the confetti jump to the comb. Once in contact with the comb, negative charge is conducted to the confetti, making it negative. Because the confetti is now negatively charged like the comb, it is repelled.
6. Conduction is the direct transfer of charge through touch. Induction is the indirect charging of an object without touching.
7.
 - a) Diagram should show an excess of negative charge on the hand (indicated by more “_” than “+” signs). The hand should be approaching but not touching the nozzle. The nozzle is positively charged (indicated by more “+” than “_” signs).
 - b) This is charging by both conduction and induction. The man is charged by conduction as the sweater rubs over his body. The gas nozzle is charged by induction as the negative charges on the nozzle move away from the negatively charged approaching hand. This leaves the nozzle positively charged.
 - c) Sparks near flammable materials must be avoided at all cost. Avoid activities that could generate static charge while you are filling your vehicle.

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Quick Check

1. False: Current is electricity that flows.
2. True
3. True
4. False: Voltmeters must be connected across devices in a circuit.
5. True

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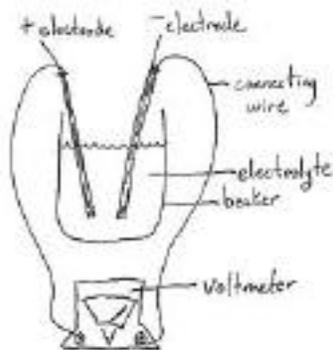
4.1.2 Review Questions

1. Voltage is the measure of how much electrical energy a charged particle carries in a circuit.
2. Static is a buildup of charge on an object, while current is the continuous flow of charged particles.
3. Current: amperes; voltage: volts. Voltage is the measure of how much energy each particle carries, while current is a measure of the number of charged particles that pass a point each second.
4. a) Loads convert electrical energy to other forms of energy in a circuit. A light bulb converts electrical energy to heat and light.
b) The voltmeter must be connected across the bulb. Voltmeters detect potential difference; therefore, they must be connected across devices.
c) There is a drop in potential difference across load devices, so referring to the reading as a “voltage drop” is correct.
5. Conductors are materials through which electricity can readily flow.
6. The electrons in the circuit have not disappeared. They have stopped flowing because they need a complete circuit with a potential difference applied to allow them to flow.
7. Ammeters measure current and must be connected in series with the other devices in the circuit.

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Study Prep

Students’ diagrams should look similar to the following:



Page 148

Quick Check

1. False: A small container of chemicals that reacts to produce electricity is called a cell.
2. True
3. True
4. False: Connecting several cells together forms a battery.
5. True

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4.1.3 Review Questions

1. An ion is an atom that is electrically charged because it has gained or lost electrons.
2. An electrolyte is an electricity-conducting liquid (wet cell) or paste (dry cell) in an electrochemical cell that reacts with electrodes to form ions.
3. a) A wet cell requires two different metals as electrodes.
b) A wet cell requires two different metals as electrodes; one electrode is insufficient.
c) Distilled water is inadequate as an electrolyte. An acid capable of reacting with the metal electrodes would be more appropriate.
4. The amount of chemicals in a dry cell is limited. Once the chemicals are all used up, the dry cell can no longer provide electrical energy.
5. A battery is two or more cells connected together.
6. Secondary cells can be recharged, primary cells cannot.
7. Wet cells are cheaper to construct, so making a larger battery than can provide enough electricity for the truck is more economical. Since the battery will always be in the upright position, a dry cell is not necessary. Finally, a wet cell is easy to recharge, so it can be used for a longer time than a dry cell.
8. An external source of electrical energy must be applied to the rechargeable battery.

Page 153

Quick Check

1. False: Electrons are loosely bound to the nucleus in metals.
2. True
3. False: An open switch prevents current flow.
4. True
5. True

Page 154

Study Prep

1. 160
2. 240 V
3. 1.33 A

Page 155

4.2.1 Review Questions

1. A resistor is a device that resists and reduces the flow of current in a circuit.
2. The two are directly related. As voltage increases, current increases.
3. Conductors such as metals have electrons that are loosely bound to the nuclei and can easily begin flowing through the metal when voltage is applied. The electrons in the insulators are so tightly bound to the nucleus that they resist flowing.

4. When conductors touch inside a switch to complete the circuit, the switch is said to be closed.
5. a) 0.25 A
b) 0.083 A
6. 0.0200 A
7. 11.5
8. 80 V
9. 15

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Quick Check

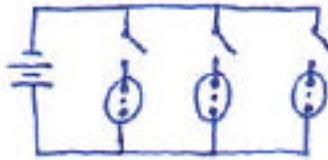
1. False: Devices connected in parallel have separate current pathways.
2. False: Bulbs connected in series will not operate if one bulb burns out.
3. False: Adding more resistors in a series circuit increases overall resistance.
4. True
5. False: The schematic symbols are similar, but the symbol for the battery is multiples of the symbol for the cell.

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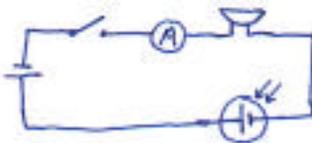
Develop Your Skills

Answers will vary. Below are examples of typical student diagrams.

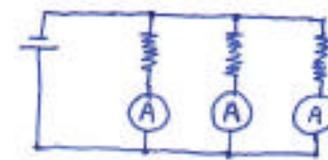
1.



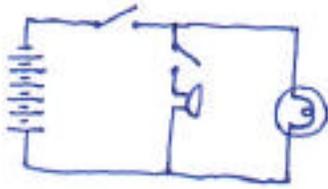
2.



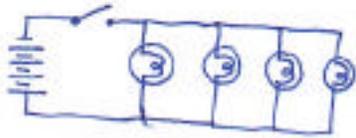
3. The entire circuit would have 6 A of current flowing through it.



4.



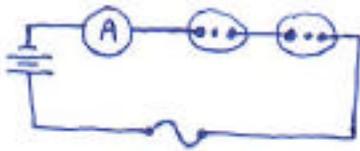
5.
Maximum brightness



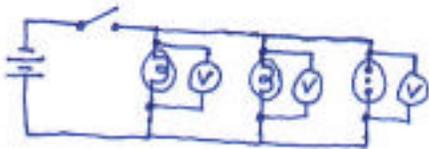
Minimum brightness



6.



7.



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Review Questions

1. a)



b)



c)



d)



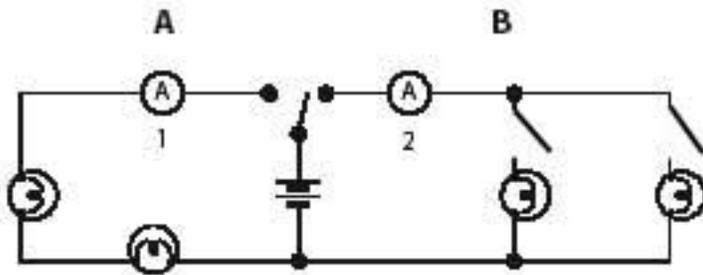
e)



f)



2. Adding more resistors in a series circuit increases resistance and decreases current.
3. Home wiring is in parallel so that if components in the circuit fail, the other components will continue to function.
4. The circuitry in a computer processor is reduced in size to a very small scale. Transistors are used to control current without moving parts.
5. Dimmer switches have a variable resistor. By adjusting the dimmer, more or less of the resistor is made part of the circuit, therefore changing the current flowing through the circuit. With more current, the lights get brighter; with less current, the lights get dimmer.
6. a) Side B will glow more brightly. When connected in parallel, the bulbs offer less resistance in the circuit, allowing each bulb to draw more current.
b)



- c) It will read 1 A. When connected in parallel, a total of 4 A flows in the circuit; therefore, each bulb must draw 2 A. Connecting the bulbs in series increases resistance (the resistance of the bulbs is added together) so the current in the circuit drops.

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Quick Check

1. False: Magnetic flux decreases as you move away from a magnet.
2. False: Breaking a magnet produces two smaller magnets.

3. False: Oersted discovered that a current-carrying wire produces a magnetic field.
4. False: The thumb points in the direction of current flow.
5. False: Magnetic fields are invisible.

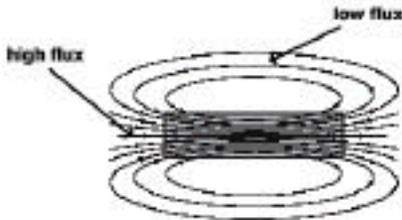
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Study Prep

Answers will vary. A magnetic concept map should differentiate between permanent and electromagnets. Aspects of natural magnetism such as flux and domains would fall under the permanent part of the map, while Oersted and the hand rules would fall under the electromagnetic portion of the map.

Page 169–170
4.3.1 Review Questions

1. The unlike poles of magnets are attracted to each other, that is why the top of one piece is attracted to the bottom of the next.

2.



3. The drawing should show the magnets stacked vertically on the chopstick with like poles facing each other.
4. [Note: The question should refer to the magnetic flux drawing in question 2.] See answer to question 2 above.
5. “Ferromagnetic” refers to metals that have groups of atoms that can respond to external magnetic fields.
6. Dropping a permanent magnet puts the areas of magnetic influence (domains) out of alignment.
7. Arrow A. If the magnets repel, then the N-pole of the electromagnet must be facing the permanent magnet. Using the second left hand rule with the thumb pointing toward the N-pole, the fingers indicate the electron flow in the wire.

8.



9. Conventional current is in the direction opposite to electron flow.

Page 174**Quick Check**

1. False: The armature is the rotating electromagnetic axle of the motor.
2. True
3. False: AC continually changes direction.
4. False: A step-down transformer is used to reduce voltage.
5. True

Page 176**4.3.2 Review Questions**

1. Permanent magnets repel and attract the electromagnetic armature of the motor, causing it to spin.
2. No. Without the commutator, the armature would make only one-half turn and then would be locked in position by magnetic attraction.
3. Step-down transformers are used to reduce voltage to usable levels.
4. AC is current that continually reverses direction, while DC flows in only one direction.
5. Electromagnetic induction is when current is produced via the interaction of a magnet and a conducting wire.
6. Motors and generators both contain coils of wire mounted on a rotating axle and permanent magnets. Motors convert electrical energy into mechanical energy, and generators do the opposite.
7. A step-up transformer would be needed. The diagram should indicate more coils on the side connected to the picture tube. It will probably resemble Figure 4.33b on page 173 in the student book.
8. This statement is incorrect. An electrochemical cell uses a chemical reaction to create current, while a generator uses electromagnetic induction to generate current.

Page 179**Study Prep**

1. 90 W
2. 25 V
3. 1.83 A

Page 181**Study Prep**

1. 138 W
2. 7.5 minutes
3. 4.9 MJ

Page 182–183

4.4.1 Review Questions

1. Power is measured in watts and reflects the rate at which a device uses energy. Energy is the ability to do work and is measured in joules.
2. The kilowatt hour is a larger unit of energy. It is more practical to use when tracking consumer electrical energy consumption, which is usually millions of joules every month.
3. 240 kJ
4. 288 kJ
5. 33.3 minutes
6. 3.33 A
7. \$4.32
8. \$8.06
9. a) Friday (35 kW•h)—determined by subtracting from the previous day’s reading.
b) Wednesday (8 kW•h)—determined by subtracting from the previous day’s reading. Wednesday had the lowest consumption, probably because there was no one home to use electrical appliances.
c) No. Without a reading from Saturday, it is impossible to subtract to find the consumption for Sunday.

Page 186

Quick Check

1. False: A short circuit occurs when electricity departs from its designed pathway.
2. False: Insulators are materials that do not allow the free flow of electric charge.
3. True
4. True
5. False: A current of 0.1 A is potentially fatal.

Page 186–187

4.4.2 Review Questions

1. A short circuit is when electricity departs from its designed pathway.
2. Insulators are materials that do not allow electric charge to flow freely, so they are often used to coat conductors. This prevents users from contacting conductors and the potentially dangerous charges they carry.
3. High voltage is dangerous because it is often associated with dangerous levels of current. However, amps are actually more dangerous, because a very small amount can be fatal.
4. a) A circuit breaker is a switch that turns off electric current when it exceeds a certain value. This prevents current overloads and the fires they can cause.
b) The three-prong plug has a ground pin that connects to the safety ground wiring of the home. If a short circuit occurs, current flows to the ground instead of the user.

- c) A fuse melts and interrupts the flow of current when current flow is excessive. This prevents current overloads and the fires they can cause.
 - d) Lightning rods are a building safety feature. They attract lightning and conduct the current harmlessly to the ground. This prevents lightning strikes on other parts of the building.
5. No. Lightning tends to strike high points on the horizon, like trees.
 6. Current flowing through the body can cause loss of muscle control. If the electrician grabbed the wire to test it, he would not be able to let go.
 7. It is a bad idea because tap water can conduct electricity. If the circuitry of the TV set came in contact with the water, he could be electrocuted.
 8. Lightning starts with huge turbulent clouds that build up large amounts of electrons at the bottom due to collisions of water droplets and ice. The large potential difference that forms between the cloud and ground eventually creates a plasma (ionized air). When a complete conductive ionized pathway forms between the cloud and ground, the electrons in the cloud move to the ground.
 9. The farmer is not electrocuted because the tractor is insulated from the ground by its rubber tires, preventing a complete conductive pathway from forming. The farmer should wait for help until the electricity can be turned off, but failing that, she should jump clear of the tractor (holding onto the tractor while touching the ground would form a conductive pathway through her) and hop away with feet together.

Page 189

Quick Check

1. False: The law of conservation of energy is also known as the first law of thermodynamics.
2. True
3. True
4. True
5. True

Page 190

Quick Check

1. True
2. False: Replacing a less efficient device does not save energy if it takes more energy to create the new device than would be saved by replacing it.
3. False: An EnerGuide label tells you the average energy consumption of the device.
4. True
5. False: You can reduce electricity consumption by replacing wasteful devices with ones that use less energy to do the same task.

Page 191–192

4.4.3 Review Questions

1. The law of conservation of energy states that energy cannot be created or destroyed.

2. No. The amount of energy saved would not justify the energy consumed to make the new bulbs. The cost of buying the new bulbs would likely not be recovered in energy savings either.
3. An EnerGuide label provides information about the amount of energy the appliance will consume on average for a typical month's use.
4. A less wasteful device uses less energy to perform the same task.
5. Energy waste is a form of energy produced during conversions that is not useful or desirable to us.
6. Energy dissipation is the energy lost as heat to the surroundings when a mechanical system operates.
7. Answers will vary. Some possibilities are:
 - Turn off lights when not in use.
 - Replace wasteful devices with efficient models.
 - Maximize insulation to reduce heating and cooling costs.
8. The choice is wise in regard to the environment because the rechargeable batteries can be used repeatedly. This reduces the amount of cells that go into the garbage. In regard to energy conservation, there may be slight savings because less energy is consumed to make fewer cells, but this is counteracted by the energy need to recharge the cells.

Pages 193_195

Unit Review

1. B
2. A
3. C
4. C
5. D
6. C
7. B
8. C
9. B
10. A
11. D
12. A
13. B
14. B
15. B
16. A
17. C
18. C
19. D
20. D
21. A
22. D

- 23. A
- 24. D
- 25. C
- 26. A
- 27. B
- 28. F
- 29. E
- 30. D
- 31. A
- 32. C
- 33. A
- 34. D
- 35. D
- 36. B
- 37. B
- 38. C