Get Ready for Unit 4

The Characteristics of Electricity

Answers for page 140

Multiple Choice

1. e

2. d

3. c

4. b

5. b

6. b

7. a

8. d

Answers for page 141

Written Answer

9. Static electricity is the build-up of an electric charge on the surface of an object, and current electricity is electric charge in motion.

10. A conductor is a material that allow charges to flow through it freely.

11.

Device	Energy Conversion
Coffee maker	electrical energy to heat energy and sound energy
Light bulb	electrical energy to heat energy and light energy
Refrigerator	electrical energy to mechanical energy to heat (cold) energy

12. The three main components in a circuit are the power source, load, and conductors (wires).

13. a. This is a series circuit. **b.** This is a parallel circuit. **c.** This is a parallel circuit.

14. An insulator is a material that does not allow electric charges to flow through it.

15. Cost = 4.0¢/kW•h × 350 kW•h = $14.00

16. Cost = 8.0¢/kW•h × 350 kW•h = $28.00. Therefore, it will cost $28.00 – $14.00 = $14.00 more, or double, during the peak times on winter weekdays.

Section 10.1 Review

Exploring Static Charges

Answers for page 142

Multiple Choice

1. b

2. b

3. c

4. d

5. b

6. a

7. a

8. c

Answers for page 143

9. a

10. d

11. e

12. b

13. d

14. d

15. e

16. a

Answers for page 144

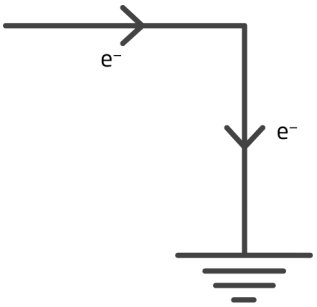
Written Answer

17. Dust particles are attracted to a newly polished car because the newly polished car is charged by friction and the neutral dust particles are attracted to it.

18. A semiconductor is a material in which electrons can move fairly easily.

19. Grounding means removing static electric charges from a charged object by providing a safe path for electrons to travel to or from the ground.

20.



21. Electrical equipment and the people working on it are grounded to eliminate the risk of a rapid transfer of electrons (discharge) to the equipment and to the people.

22. When your hand touches the metal doorknob, there is a rapid discharge of electrons and you feel a shock. When your hand touches a wooden doorknob, there is a slower transfer of electrons and you do not feel a shock.

23. When different materials are rubbed against each other, the loosely held electrons from one material get transferred to the other material. As a result, one object becomes positively charged while the other becomes negatively charged.

24. Plastic and rubber are materials that do not conduct electrical charges. These materials make sure the transfer of electric charges is slower. This prevents the user from getting a shock.

Answers for page 145

25. In part A, the girl's hair and the plastic comb both have neutral charge.

26. In part B, the girl's hair has a positive charge and the plastic comb has a negative charge.

27. The comb moved through the hair. When two neutral objects made from different materials rub against each other, there is a transfer of electrons. In this case, the electrons transfer from the girl's hair to the comb.

28. Accept any two of the following: Particles that carry electric charges can neither be created nor destroyed. Any net charge on a solid object, whether it is positive or negative, results from the transfer of electrons between this object and another object. Compared

with a neutral object, an object with an excess of electrons (more electrons than protons) has a negative charge. Compared with a neutral object, an object that has fewer electrons than protons has a positive charge. Different materials hold on to their electrons with different strengths.

29. An anti-static sheet contains a waxy compound. Hot air from the dryer vaporizes the waxy compound, which then coats the clothes. The coating causes the clothes to behave as if they were made from the same material, so no static charge builds up.

30. Some of the gases that are used for anesthesia are explosive, so a spark produced as a result of static charge could cause an explosion.

31. Clothing worn by doctors and nurses in an operating room is made using fibres that conduct well. Rubber and wool do not conduct well.

32. Chains that touch the road ground the truck. The truck needs to be grounded to prevent static charge build-up, which is dangerous in the presence of gasoline.

Section 10.2 Review

Charging by Contact and by Induction

Answers for page 146

Multiple Choice

1. b

2. a

3. b

4. b

5. c

6. c

7. b

8. d

Answers for page 147

9. d

10. e

11. e

12. e

13. b

14. e

15. e

16. c

Answers for page 148

Written Answer

17. A positive charge will move in the direction of the lines of the electric field of the positive charge.

18. Sphere A is negatively charged, and sphere B is positively charged.

19. The function of an electroscope is to detect charges.

20. When a neutral object is charged by induction, it gains a charge opposite to the charge of the charging object.

21. During charging by friction, the electrons are transferred from the material with a weak hold on electrons to the material with a strong hold on electrons. During charging by contact, the positively charged object takes electrons from the neutral object and makes it positive. A negatively charged object gives electrons to the neutral object and makes it negative.

22. Electrons move through a conductor.

23. The size of the electric force between two charged objects is directly proportional to the amount of charge on each object.

24. If the distance between two charged objects increases, the electrical force between them decreases.

Answers for page 149

25. The amount of net charge on an object is the difference between the number of protons and the number of electrons that the object contains.

26. In A, the pith ball is brought near the positively charged rod. In B, the pith ball is attracted to the rod and touches it. During contact, the pith ball transfers some electrons to the rod and becomes positively charged. In C, the pith ball repels because its charge is the same as the charge on the rod.

27. Repulsion is the test for charge.

28. If the object is attracted by both negatively and positively charged objects, the object has a neutral charge.

29. When the object is brought near an electroscope and the electroscope's leaves are not affected, the object is neutral. If the electroscope's leaves separate, the object is charged.

30. The electric force can be repulsive or attractive, but the force of gravity is always attractive.

31. The electric force and the gravitational force both decrease as the distance between the objects increases.

32. The three elements of an electroscope are the two lightweight metal strips (leaves), metal rod, and metal sphere. They are made of metal because they must allow electrons to flow through them freely (that is, they must be conductors).

Section 10.3 Review

Charges at Work

Answers for page 150

Multiple Choice

1. d

2. a

3. e

4. e

5. a

6. e

7. b

8. e

Answers for page 151

Written Answer

9. Electric charges are used to control pollution, reduce waste, and monitor the safety of workers exposed to radiation.

10. In Canada, lightning strikes occur most frequently in June, July, and August.

11. The paper becomes charged after being rolled in the photocopier. Clothes have a neutral charge, so the paper is attracted to the clothes.

12. Electrostatic spray painting reduces over-spraying, which means that it uses less paint and releases less paint to the environment.

13. The charge on a Van de Graaff generator is generated on the rubber belt.

14. The charge on a Van de Graaff generator is collected on the metal sphere.

15. In a Van de Graaff generator, charging takes place by friction between the belt and the comb.

16. The property of selenium that makes it useful in a photocopier is its ability to conduct differently under different light conditions. Selenium is only a fair conductor in the dark, but it becomes a very good conductor when exposed to light.

Chapter 10 Review

Static Charges and Energy

Answers for page 152

Multiple Choice

1. c

2. a

3. c

4. b

5. a

6. a

7. d

8. b

Answers for page 153

Written Answer

9. Copper and silver are good conductors of electricity.

10. Wood and rubber are good insulators.

11. An electroscope is grounded by touching its spherical top.

12. Lightning rods, spray painting, air filters, and electrostatic precipitators use the electrostatic principles.

13. You feel an electric shock when a relatively large number of electrons flow rapidly through your body.

14. The purpose of a ground is to supply a very large number of electrons to, or remove a very large number of electrons from, a charged object. The ground is connected to Earth.

15. I would use a comb made of metal. Electrons will flow through my hand and no charge will build up.

16. In A, when the positively charged rod is brought near the sphere, the side of the sphere facing the rod becomes negatively charged (induction). In B, when the rod touches

the sphere (contact), electrons are transferred from the sphere to the rod, making the sphere positively charged.

Answers for page 154

Written Answer

17. Wool has a weaker hold on electrons, so the wool carpet will become positively charged and the cotton socks will become negatively charged.

18. Bring the ebonite and glass rods near the material. If the charge on the material is the same as the charge on the rod, it would move away (repelled) from the rod. If the charge on the material is different from the charge on the rod, it will be attracted to the rod.

19. If two objects made of the same material are rubbed together, there will be no transfer of electrons and neither object will get charged.

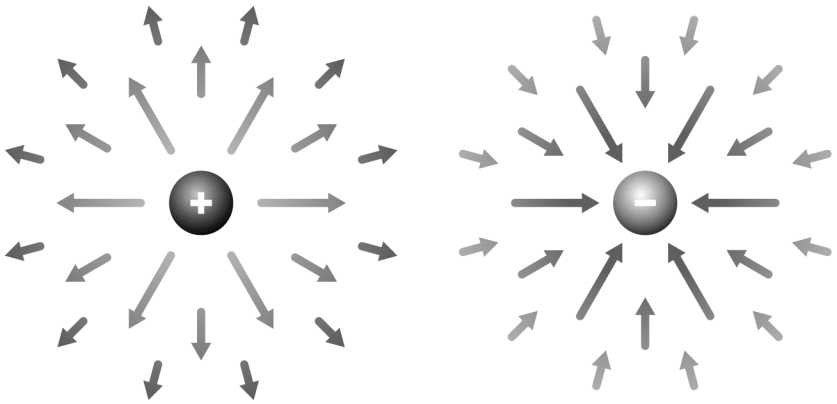
20. a. iii **b.** i **c.** iv **d.** ii

21. During a lightning strike, air is rapidly heated by the flow of charge, and the shock wave produced is heard as thunder.

22. Light travels at 3×10^8 m/s. Sound travels at approximately 320 m/s. The speed of light is much faster than the speed of sound, so you see the lightning before you hear the thunder.

23. Conductors have free electrons that are charge carriers, but insulators do not have many free electrons.

24.



Answers for page 155

25. A. Air currents in the storm cloud cause charge separation. The top of the cloud becomes positively charged, and the bottom becomes negatively charged. B. Negative charges on the bottom of the cloud induce a positive charge on the ground below the cloud by repelling negative charges in the ground. C. When the bottom of the cloud has

accumulated enough negative charges, the attraction of the positive charges below causes electrons in the bottom of the cloud to move toward the ground. D. When the electrons get close to the ground, they attract positive ions, which surge upward, completing the connection between the cloud and the ground. This is the spark you see as a lightning flash.

26. First, bring a positively charged rod near the sphere. The electrons will move to this side of the sphere and leave the other side positively charged. Second, with the rod in place, touch the sphere to ground it. The electrons on the near side will remain in place, and the electrons will move from the ground and neutralize the positive side of the sphere. The sphere now has excess electrons. Third, remove the ground with the rod in place. Fourth, remove the rod. The sphere is now negatively charged.

27. The factors that affect the force between two charges are the magnitudes of the charges and the distance between them.

28. Taking cover under a tree is not safe because lightning usually strikes the highest object in the area, such as a tree.

29. Silver tarnishes and it is expensive.

30. a. iv **b.** i **c.** v **d.** ii **e.** iii

31. When two highly charged objects are close enough that the charges can jump (discharge) through the air, electric sparks are produced.

32. Sparks are produced as a result of induction.

Section 11.1 Review

Cells and Batteries

Answers for page 156

Multiple Choice

1. a

2. d

3. d

4. e

5. d

6. c

7. d

8. a

Answers for page 157

Written Answer

9. A primary cell can be used only once. A secondary cell can be recharged.

10. A typical cell creates a chemical reaction using the material inside the cell, but a fuel cell generates electricity by using chemical reactions of fuel that is stored outside the cell.

11. A solar cell converts sunlight into electrical energy. When sunlight strikes a semiconductor, such as silicon, electrons are knocked loose from the atoms.

12. A dry cell contains an electrolyte that is a paste, whereas a wet cell contains an electrolyte that is a liquid solution.

13. A lead-acid battery is heavy, it contains a corrosive electrolyte, and it has a short storage life.

14. The two essential elements are the electrodes, which are the two metal terminals in the cell, and the electrolyte, which is a solution or paste that conducts charge.

15. A battery is a connection of two or more cells.

16. The cell in the diagram is a nickel-cadmium secondary cell. It is hazardous to the environment because of the cadmium.

Section 11.2 Review

Electric Circuits: Analogies and Characteristics

Answers for page 158

Multiple Choice

1. b

2. c

3. d

4. b

5. e

6. e

7. a

8. e

Answers for page 159

Written Answer

9. A switch is a conducting control device that is connected in a circuit to complete or break the circuit. It is included for safety reasons.

10. An open switch means that the circuit is incomplete and no current can flow through. A closed switch means that the circuit is complete and current can flow through.

11. In conventional flow, the current flows from the positive to the negative terminal of the battery. In electron flow, the electrons flow from the negative to the positive terminal of the battery.

12. The separation of charges between the two electrodes in a cell gives rise to an electric field. This field transmits an electric force to the electrons in the circuit, which then flow to form a current.

13. A conductor allows electrons to flow more easily through it than an insulator does. As a result, the loss of energy for the electrons and the potential difference are much lower in a conductor.

14. In A, the box is raised, which increases its gravitational potential energy. In the same way, the electric field of the power source does work on the electrons and increases the

electrical potential energy of the electrons. In B, the box has fallen down and has lost its energy. In the same way, the electrons do work when they travel through a load and lose electrical potential energy.

15. The potential difference is 3.0 V.

16. Current is the amount of charge that flows through a point in a circuit per second. Potential difference is the change in the potential energy per unit charge.

Section 11.3 Review

Measuring the Properties of Simple Circuits

Answers for page 160

Multiple Choice

1. b

2. e

3. b

4. d

5. b

6. d

7. e

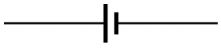
8. a

Answers for page 161

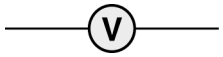
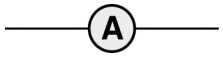
Written Answer

9. Switches, fuses, and circuit breakers are crucial to the safe operation of electrical systems.

10.

Circuit Component	Circuit Symbol
Connecting wire	
Cell	
Resistor	
Switch	

11.

Circuit Symbol	Circuit Component
	Battery
	Bulb
	Voltmeter
	Ammeter
	AC power supply

12. An ammeter is always connected in series. A voltmeter is always connected in parallel to measure the potential difference across the load.

13. The ammeter has to measure the flow of electric charge (the current) at a point in the circuit. So, it has to be connected in series.

14. A voltmeter measures the difference in the potential energy between two points in a circuit. So, it is connected in parallel across two points.

15. The potential difference that is generated by a cell is limited to a few volts. A larger potential difference is required to operate the starter motor on a car.

16. The cells must be connected in series. To connect the cells in series in a battery, the positive terminal of one cell is connected to the negative terminal of another cell.

Section 11.4 Review

Measuring Electrical Resistance

Answers for page 162

Multiple Choice

1. c

2. b

3. b

4. b

5. b

6. c

7. d

8. b

Answers for page 163

Written Answer

9. Ohm's law states that, for most conductors, the ratio of potential difference (V) to current (I) is a constant, and this ratio is called the resistance (R).

10. A resistor is an electrical component with a specific resistance.

11. The unit for resistance is the ohm (Ω). One ohm is equivalent to one volt per ampere (V/A).

12. The four factors that affect the resistance of a wire are the type of material the wire is made of; the length of the wire (a longer wire has greater resistance); the diameter of the wire (a wire with a larger diameter has lower resistance); and the temperature of the wire (a hotter wire has greater resistance).

13. A superconductor is a material through which electric charge can flow with no resistance.

14. An ohmic resistor obeys Ohm's law, and a non-ohmic conductor does not obey Ohm's law.

15. The direction of the conventional current is ABCD.

16. The direction of electron flow is DCBA.

Section 11.5 Review

Series and Parallel Circuits

Answers for page 164

Multiple Choice

1. a

2. c

3. a

4. d

5. d

6. e

7. e

8. b

Answers for page 165

Written Answer

9. The total resistance is 60 Ω.

10. The current is 0.20 A.

11. The potential differences across the resistors are $V_1 = 5.0$ V, $V_2 = 3.0$ V, and $V_3 = 4.0$ V.

12. 12 V = 5.0 V + 3.0 V + 4.0 V

13. $V_1 = V_2 = V_3 = V_T = 20$ V

14. $I_1 = 4.0$ A, $I_2 = 2.0$ A, and $I_3 = 1.0$ A.

15. $I_T = 7.0$ A

16. $R_T = 2.9$ Ω

Chapter 11 Review

Electric Circuits

Answers for page 166

Multiple Choice

1. e

2. e

3. c

4. e

5. e

6. b

7. c

8. d

Answers for page 167

Written Answer

9. The current is the same through all four resistors, and the potential difference is different across all four resistors.

10. The current is different through all four resistors, and the potential difference is the same across all four resistors.

11. The total resistance is 50 Ω.

12. The total resistance is less than 8 Ω.

13. The potential differences are 30 V and 30 V.

14. The currents are 0.24 A and 0.33 A.

15. The total current is 0.58 A.

16. The resistance is 5×10^2 Ω.

Answers for page 168

17. A fuel cell generates electricity through the chemical reactions of fuel that is stored outside the cell. A hydrogen fuel cell combines hydrogen that is stored in a tank or cartridge with oxygen from the air.

18. The by-products of a fuel cell are heat and water.

19. There are several ways that society can meet its transportation needs in an environmentally friendly way. Some suggestions are driving an electric car, especially for short distances; car-pooling to school or work; combining errands and other trips to reduce the amount driven; using public transportation; and walking or riding a bicycle instead of driving.

20. The unit for electric current is the ampere. Current is measured using an ammeter.

21. A dry cell contains an electrolyte that is a paste, whereas a wet cell contains an electrolyte that is a liquid solution.

22. 1.9×10^{18} electrons

23. The slope represents the resistance.

24. The resistance is 20 Ω.

Answers for page 169

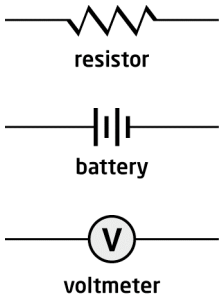
25. The resistance is 0.800 Ω.

26. The resistance is 9 Ω.

27. The current will not flow through B_1. Current follows the path of least resistance, which is the connecting wire on the right of B_1. This is called a short circuit.

28. In an open circuit, the current cannot flow because the circuit is broken, but the potential difference between the broken points is non-zero. In a short circuit, the load is bypassed by a connecting wire so that no current is able to flow through the load.

29.



30. The potential difference of the power supply is 9 V.

31. R_1, R_2, and R_3 are connected in series, and these three are connected in parallel with R_4.

32. The total current in this circuit is divided between R_4 and the other three resistors. The currents in R_1, R_2, and R_3 are the same.

Section 12.1 Review

12.1 Electricity at Home

Answers for page 170

Multiple Choice

1. d

2. e

3. c

4. e

5. a

6. e

7. e

8. c

Answers for page 171

Written Answer

9. For DC, electrons travel through a circuit in only one direction. For AC, electrons move back and forth in a circuit.

10. *Sample answers*: A toaster uses the heat generated by an AC current. The heat generated is hot enough to toast the bread. A kettle uses the heat generated by an AC current. The heat generated is hot enough to boil the water.

11. A generator is an electrical device in which a shaft moves (mechanical energy) in a magnet and generates electricity (electrical energy).

12. A transformer is an electrical device that changes the potential difference of an AC current.

13. The two types of transformers are a step-up transformer and a step-down transformer. In a step-up transformer, the output voltage is higher than the input voltage. In a step-down transformer, the output voltage is lower than the input voltage.

14. A source of energy, such as moving water, wind, steam, or nuclear reactions, is used to spin the shaft of the generator. Energy from the shaft moves a magnet or a coil of wire

to get relative motion between the two. The relative motion generates an electric field, which causes electrons to move and form a current.

15. AC is safer to use in households. AC can be transmitted at high potential difference to minimize heat losses and then stepped down for usage with the help of transformers. Transformers do not work with DC.

16. Diagram A is a panel consisting of circuit breakers. A circuit breaker is a safety device that is placed in series with other circuits, which lead to appliances and outlets. Diagram B is a fuse. A fuse is a safety device found in older buildings and some appliances. Like a circuit breaker, it is placed in series with other circuits, which lead to appliances and outlets.

Section 12.2 Review

Using Electrical Energy Wisely

Answers for page 172

Multiple Choice

1. e

2. d

3. c

4. b

5. e

6. c

7. b

8. d

Answers for page 173

9. b

10. b

11. c

12. e

13. b

14. a

15. d

16. a

Answers for page 174

Written Answer

17. A consumer might choose an Energy Star rated appliance because its operating costs will be lower.

18. An appliance earns an Energy Star® rating when it uses 10 percent to 50 percent less energy when compared with a standard appliance in the same category.

19. Electrical energy is the energy that a device uses at a given setting. It is determined by multiplying the power rating of the device by the length of time it is used.

20. In Ontario, the electricity wasted by using incandescent light bulbs could power 600 000 homes.

21. The EnerGuide label on an appliance provides details about how much energy the appliance uses in one year of normal use.

22. a. The microwave uses 3.85 kW•h per week. **b.** It costs 30.8¢, or approximately 31¢.
23. The efficiency of an electrical device is defined as the ratio of the useful output to the energy consumption or input of the device. Efficiency = (output/input) × 100%

24. External power adapters are considered inefficient because they give off a substantial amount of heat.

Answers for page 175

25. The intervals are adjusted twice each year because the demand for electricity changes with summer and winter.

26. The cost of electricity depends on the amount of energy that is used and the price that is charged for it.

27. Efficiency is a measure of useful work relative to the energy consumption of the appliance. So, it is important to compare this quantity for two appliances to find out which appliance uses less energy.

28. The efficiency is 25 percent.

29. The motor does 175 kW•h of useful work. 175 kW•h = 175 kW•h $\times 3.6 \times 10^6$ J = 6.3 $\times 10^8$ J

30. The cordless telephone consumes 0.060 kW•h.

31. A smart meter is a device that records the total electrical energy used hour by hour and automatically sends this information to the utility company.

32. Time of use pricing is a system in which the price that is charged for each kW•h of energy used is different at different times of the day or week.

Section 12.3 Review

Meeting the Demand for Electricity

Answers for page 176

Multiple Choice

1. b

2. c

3. d

4. e

5. e

6. a

7. b

8. a

Answers for page 177

Written Answer

9. Nuclear, coal, oil, and gas sources of energy all work in this way.

10. The base load is the continuous minimum demand for electrical power. In Ontario, the base load is about 12 000 MW early in the morning. The base load is generated mainly by hydroelectric and nuclear generating stations, but also by some coal-fired generating stations.

11. The intermediate load is the demand for electricity that is greater than the base load and less than the peak load. In Ontario, the intermediate load is between approximately 15 000 MW and 20 000 MW. It is met by generating stations that burn fossil fuels.

12. The peak load is the greatest demand for electricity. In Ontario, the peak load is above 20 000 MW. It is met by using hydroelectric and gas turbines, which can be turned on and off quickly.

13. A renewable energy source is one that can be replaced in a relatively short period of time, such as hydro power. A non-renewable energy source is one that cannot be replaced as quickly as it is used, such as fossil fuels.

14. The coal is mined, placed on a conveyor belt, and pulverized. The pulverized coal is burned to boil water. The steam from the water goes into a turbine, which runs a generator. The generator produces electrical energy. The exhaust steam from the turbine is recycled. It is condensed to water and moved back to the combustion chamber to be boiled again.

15. When reservoirs are built to store water in dams, large areas of land must be flooded. When land is flooded, the submerged vegetation decays. This can lead to the production of methane, a greenhouse gas. Mercury, a toxic metal, is released from the soil and vegetation and is taken up by whatever fish manage to survive.

16. The advantages of using coal are that it is readily available and the economic costs of generating electrical energy from it are relatively low. The disadvantages are that the conversion of energy from coal to electricity is very inefficient; burning coal produces gases that contribute to acid rain, particulates, and other emissions, including carbon dioxide, a greenhouse gas; and coal is non-renewable, meaning that supplies will eventually run out.

Section 12.4 Review

Sustainable Sources of Electricity

Answers for page 178

Multiple Choice

For each question below, select the best answer.

1. a

2. d

3. d

4. e

5. d

6. b

7. c

8. e

Answers for page 179

Written Answer

9. To determine the amount of useful solar energy that a solar cell would receive, the cell's position on Earth needs to be considered, as well as weather and seasonal changes, including the number of daylight hours.

10. The advantages of solar energy are that it is free and it has very little negative impact on the environment. The disadvantages are that solar energy is not very concentrated, it is not very efficient compared with other energy sources. Also, solar cells are expensive. Solar cells generate DC, while most appliances use AC. Batteries are needed to store energy for use at night and on cloudy days.

11. Tidal energy is the energy generated by ocean tides.

12. Biomass energy refers to energy that is generated from plant and animal matter.

13. Geothermal energy is energy produced from naturally occurring steam and water that is heated by hot rocks and trapped under Earth's surface. When pumped to the surface, the steam drives turbines to generate electricity.

14. The advantages are that there are very few emissions from geothermal plants, the plants can provide the base-load electricity, and they are inexpensive to run. The disadvantages are that the suitable reservoirs of very hot water are deep underground, and that the cost of drilling to extract the water is high.

15. One initiative is that common incandescent bulbs, used in homes for about 100 years, will be banned for sale in Ontario beginning in 2012. Another initiative is that smart meters will be installed to provide homeowners with information they can use to reduce their energy bills.

16. At high tide, the gates are closed, trapping water in the basin. When the tide retreats, lowering the water level, the gates are opened. As the water leaves the basin, it turns the turbine blades.

Chapter 12 Review

Generating and Using Electricity

Answers for page 180

Multiple Choice

1. e

2. e

3. d

4. e

5. e

6. c

7. c

8. e

Answers for page 181

Written Answer

9. The thin wires at the tops of the towers along the transmission lines are grounded to help protect the system from lightning strikes.

10. The high voltage is between adjacent wires, not between the ends of a single wire.

11. Insulators are attached to the wires to stop adjacent wires from touching and causing a short.

12. One problem is that tides vary on a 15-day cycle. Another problem is boat traffic. The third problem is that tidal stations only generate electricity for about 10 h each day, as the tide is moving in or out.

13. Customers would receive 4775 MW of power.

14. The average cost per year is $43.87.

15. The cost is 27.5¢.

16. The diagram shows how water is used to generate electricity. The turbine and generator transform the energy of moving water into electrical energy.

Answers for page 182

17. The power rating is 1200 W.

18. The heater's output is 1.3 kW.

19. The environmental cost of a fossil fuel is much higher because in a hydro plant there are no combustion emissions and no fuel costs.

20. a. You would use a surge protector. **b.** You would use a fuse or a circuit breaker.

21. According to the graph, wind speed increases as the height of the wind turbine increases.

22. The equation is $E = Pt$. The two possible units are W•s and kW•h.

23. A smart meter records the total electrical energy used each hour, so you can monitor your energy use. Smart meters encourage conservation by making us think about how and when we use electrical energy.

24. The annual cost for this lighting is $51.39.

Answers for page 183

25. Burning coal produces gases that contribute to acid rain, particulates, and other emissions, including carbon dioxide, a greenhouse gas. Coal is also non-renewable, meaning that eventually supplies will run out.

26. Wind and solar energies do not result in a lot of emission of gases to the atmosphere.

27. The device is a power bar with a switch. All appliances that are connected to the power bar can be turned off with one switch. The power bar is connected in series in relation to the devices it protects.

28. Many appliances are in stand-by mode when they are not switched on. The electricity that is consumed by an appliance when it is turned off is called the phantom load. Clock displays, such as those on microwaves and coffee makers, and external power adapters also require phantom loads. The easiest way to prevent a phantom load is to unplug an appliance when it is not in use.

29. The piece of equipment is a watt-meter. It can be used to measure the power ratings of appliances. The meter plugs into a wall outlet, and an appliance can be plugged into an outlet in the meter. The meter displays the power that is drawn by the appliance when it is on or off.

30. In the summer, when the days are longer and there are more hours of sunlight, solar panels can be used to provide electrical energy. In the winter, in a windy area, a wind generator can be used. If excess energy is produced by the solar panels or wind generator, it can be stored in lead-acid batteries.

31. Electrical energy can be generated using other forms of energy. Switching energy use to off-peak times will lower the costs and reduce the effects on the environment. Using less electricity saves even more, both in costs and in effects on the environment.

32. The output from the solar array is 27 kW•h.

Unit 4 Review

The Characteristics of Electricity

Answers for page 184

Written Answer

1. Three pieces of laboratory equipment that are commonly used to demonstrate static electricity are a gold leaf electroscope, a pith ball electroscope, and a Van de Graaff generator.

2. In the electrostatic series, the materials are arranged according to their ability to hold on to electrons. Depending on their relative abilities, when two different materials are rubbed together, the one with a weaker hold on electrons will lose them and get a positive charge. These electrons will go to the second material, giving it a negative charge. The first material is placed higher in the series, and the second material is lower.

3. Pure water is an insulator. However, it is very difficult to find pure water because water is a good solvent. Even rainwater has other substances dissolved in it. These substances make water a good conductor.

4. A is positively charged, and B is negatively charged.

5. The side of the pith ball facing A will show a negative charge, and the side of the pith ball facing B will show positive charge.

6. When A is removed and C is grounded, the electrons will flow from the pith ball to the ground, leaving C with a positive charge.

7. If A touches C (with B in place), the electrons from C would go to A to make it less positive. When A is removed, C would be left positive.

8. a. The ebonite rod has a negative charge. As a result of induction, the pith ball develops a positive charge near the rod when it is brought close to it. As a result, the pith ball is attracted to the rod. **b.** When the pith ball comes in contact with the rod, some electrons flow from the rod to the pith ball. They both then become negative. As a result, the pith ball repels the rod and it moves away.

Answers for page 185

9. Some of the ways in which we can reduce the electricity use at home are as follows: New low-wattage bulbs can be used to reduce the amount of electricity used. Restricting the use of high-wattage appliances to a minimum will also help. Unplugging all devices when they are not in use will reduce the use significantly. Buying energy-efficient appliances will reduce the amount of wasted electrical energy.

10. One of the properties of electricity is that charges repel and attract. A static charge is one in which the electric charge stays on the surface of an object, rather than flowing away quickly. Photocopiers, laser printers, scanners, static cling, and lightning are all applications of this property. Grounding of electrical equipment is another application in which electrons are attracted to or from Earth to neutralize the charge that collects on the equipment. Lightning rods also work on this principle. An electrostatic precipitator is a type of cleaner that removes unwanted particles and liquid droplets from a flow of gas by attraction of charged particles. Current electricity refers to the rate of movement of electric charge. Cells, batteries, and other power sources generate current electricity. Electric current is used to move things, for example, a motor; it is also used power light bulbs. Household appliances use electric current to operate.

11. Hydro: When reservoirs for water are built for hydro generators, large areas of land are flooded. When this happens, communities have to move out, and the vegetation dies in these lands. Mercury, a toxic metal, is released from the soil and vegetation and is taken up by whatever fish manage to survive. Moreover, a large body of still water can lead to the production of methane, a potent greenhouse gas. Nuclear: It takes a significant amount of money to build nuclear power stations. Uranium is required to run these stations, and its mining operations cause damage to the environment. Moreover, uranium is non-renewable. Nuclear reactions also produce radioactive waste that must be stored safely. The waste remains a hazard for thousands of years.

12. *Sample answer*: "Button" dry cells are silver-oxide and zinc-air cells. They are small and last a long time. However, the silver-oxide cells can be expensive, and the zinc-air cells require oxygen from the air. Solar cells are expensive. However, solar energy has very little negative impact on the environment. I would buy the solar energy calculator because of the reduced impact on the environment.

13. Copper is one of the best conductors because it offers little resistance when added to a circuit. This makes it a good material to use for connecting wires.

14. The current in the circuit with just bulb A is V/R. When two identical loads are connected in series, the resistance of the series is the sum of the two loads ($R + R = 2R$), and the current becomes half of what it was in the previous case ($V/2R$). This is why the brightness is less than it was before. In a parallel circuit, the potential difference across each bulb is the same. Thus, the current is unchanged, and the bulb shines as brightly as before.

15. The connecting cord is thicker and made of copper. So, it offers less resistance and allows more current to go to the stove, which is required. A light bulb requires high resistance to generate heat and light energy, so it is very thin and made of tungsten.

16. a. When S_1 is opened, no current can flow from the power source to the bulbs. None of the bulbs will be switched on. **b.** If S_1 is closed, all the bulbs will shine. But if S_2 is now opened, no current will flow to bulb B and it will get switched off. However, A and C will remain switched on.

Answers for page 186

Literacy Test Prep

Current Travel Needs

Multiple Choice

17. b

18. d

19. c

20. c

Written Answer

21. The electrical systems in some countries are not the same as they are in Canada. If you are travelling and intend to take electronic equipment or electrical appliances with you, then you have to take an adaptor, a transformer, or a converter to have them work.

Answers for page 187

Literacy Test Prep

Generation of Electrical Power in Ontario

Multiple Choice

22. a

23. d

24. b

25. d

26. b

Written Answer

27. The rotor is a giant magnet. The rotor moves inside the coils of copper wire. These coils are held by the stator. The turbine shaft turns the magnets.