Important Concepts . . .

Preview Review

Science *Grade 9* *TEACHER KEY*

W1 - Lesson 2: Electrical Circuits

V5-07

Important Concepts of Grade 9 Science

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W1 - Lesson 2 .....Electrical Circuits
W1 - Lesson 3A ..... Energy Consumption
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W1 - Lesson 4 .....Objects in Space
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W3 - Quiz

Materials Required

Textbook:
Science in Action 9

Science Grade 9
Version 5
Preview/Review W1 - Lesson 2 TEACHER KEY

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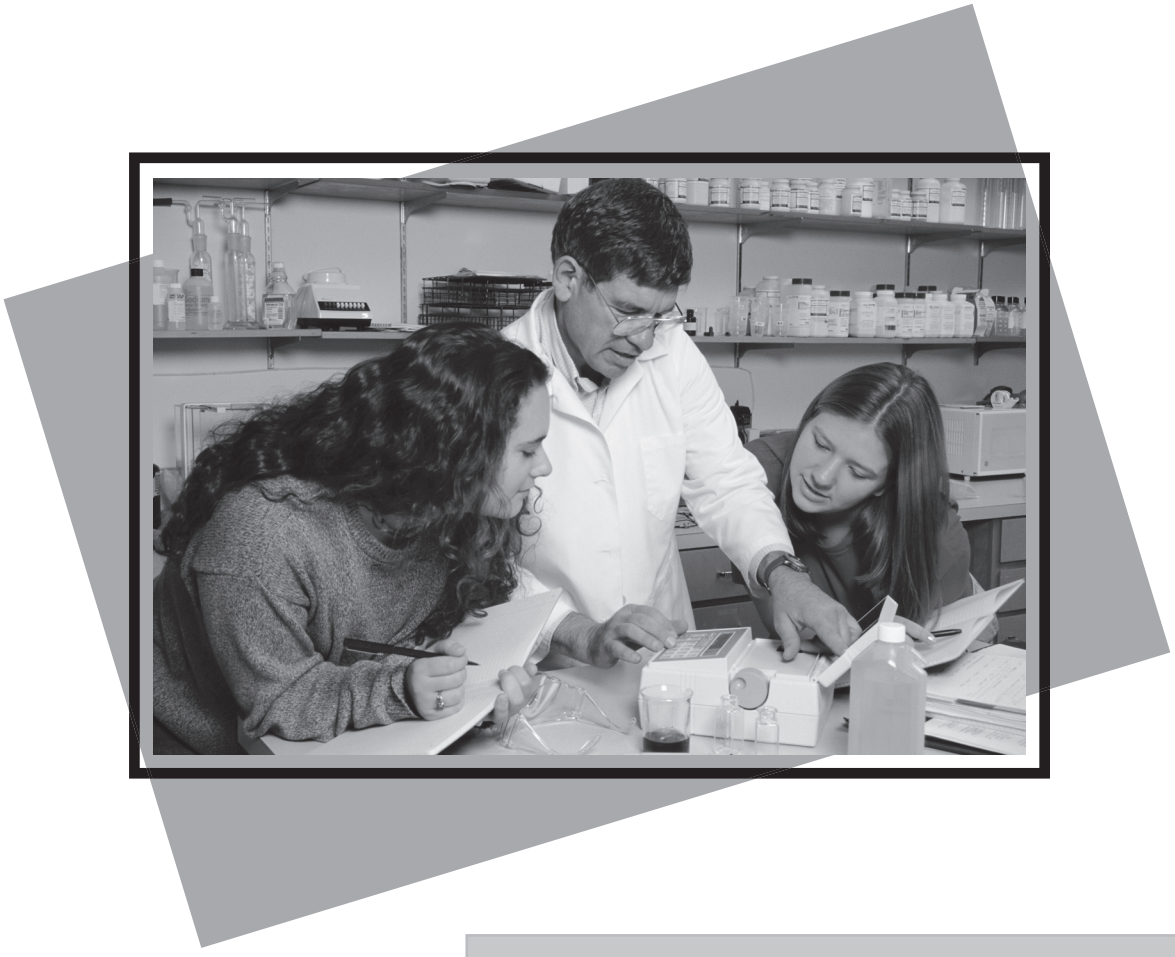
The Alberta Distance Learning Centre has an Internet site that you may find useful. The address is as follows: **http://www.adlc.ca**

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Preview/Review Concepts
for
Grade Nine Science

TEACHER KEY



W1 - Lesson 2:
Electrical Circuits

OBJECTIVES

By the end of this lesson, you should

- identify the parts and be able to draw a representation of a circuit
- understand resistance and how it affects electrical flow in a circuit
- identify devices used to test circuits
- use Ohm's law to complete calculations involving circuits
- understand the differences between series and parallel circuits

GLOSSARY

insulator - substance that strongly resists the flow of electricity

multimeter - meter that can measure voltage, current, or resistance in a circuit

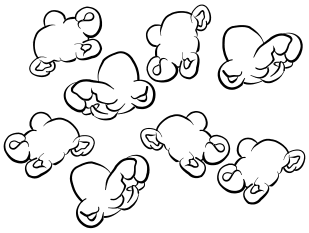
rheostat - a continuously variable resistor used to regulate electric current

semiconductor - a material, such as silicon or germanium, having a conductivity greater than an insulator but less than a good conductor

transistor - device usually with three layers arranged so that a small voltage through the middle layer controls a current between the outer layers, allowing the device to act as a switch or amplifier

voltage drop - voltage across a resistor or other device in a circuit

W1 - Lesson 2: Electrical Circuits



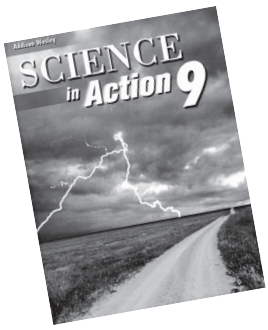
Popcorn – Mmm, an after school snack sounds wonderful! While the music is blaring on the radio, you use the hot air popcorn popper to pop some popcorn. Don't forget to melt the butter in the microwave! Nothing is happening! What's wrong? The circuit breaker has shut off the power to these appliances. Why? Does this have anything to do with circuits?

Circuit Design

You need to understand a circuit to begin to understand electricity. A **circuit** is a complete pathway through which electrical energy flows to form an electrical current. It consists of an energy source, a conductor, a switching mechanism, a resistor, and a load. The energy source supplies a steady flow of electrons. A conductor provides a path for the electrons. A switching mechanism allows the circuit to be turned on or off. A resistor is a component of a circuit that limits the flow of current. A load is something that converts energy in the circuit. A light bulb is a load because it converts electricity into light and heat energy.

Read pages 297 - 298 of *Science in Action 9*.

1. Explain the functions of an insulator, a conductor, a semiconductor, and a superconductor.



An <u>insulator</u> does not conduct electricity. The electrons are bound tightly to the positive nucleus of their atoms.

A <u>conductor</u> allows electricity to flow. Electrons can move when a conductor is connected to a voltage source.

A <u>semiconductor</u> acts like a conductor at high temperatures, but it acts like an insulator at low temperatures.

A <u>superconductor</u> has no resistance. The electrons flow freely and are not stopped by anything.

2. Identify whether the following substances are conductors, semiconductors, superconductors, or insulators.

Silver	*conductor*	Germanium	*semiconductor*
Tap water	*conductor*	Distilled water	*insulator*
Gold	*conductor*	Neon gas	*insulator*
Mercury at absolute zero	*superconductor*	Vinegar	*conductor*
Silicon	*semiconductor*	Copper	*conductor*

3. Read the materials and equipment list in the "Investigating Conductivity" lab on page 299 of your textbook.

   a. Place the materials in order from the most conductivity to the least conductivity.

   copper (II) sulfate, vinegar, salt water, tap water, distilled water

   b. Make a hypothesis to explain why the materials belong in the order that you placed them.

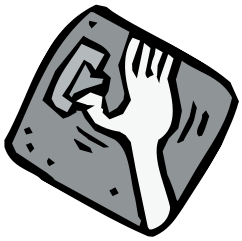
   The solutions that conduct the most electricity have the most dissolved electrolytes (ions) present in solution.

Safety mechanisms that electrical circuits in houses must have are fuses, circuit breakers, and ground wires in appliances that are plugged into the circuits. **Fuses** contain a thin metal that melts if the current passing through it is too high. A **circuit breaker** contains metal that will bend to turn off a switch to shut down the electricity in the circuit. The third protective mechanism is a ground wire. Most appliances have a metal prong that takes the electricity to the ground to prevent a person from being shocked if the electrical circuit touches the appliance.

4. Look at the label on page 285 of *Science in Action 9*. Find the voltage and current rating of the Makita appliance. Explain what would happen if a higher voltage runs through the circuit that the appliance is plugged into.

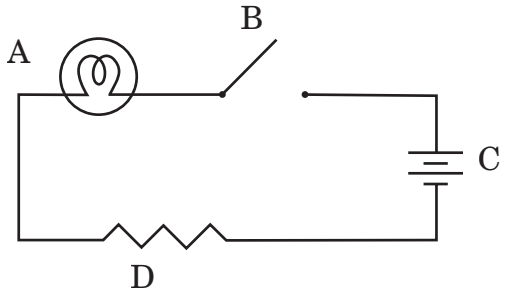
120 volt , 13 amp

If a higher voltage entered the circuit, the motor in the appliance could be damaged.



Learning to draw a representation of a circuit is part of learning about electricity. Look at page 312 of *Science in Action 9*. A chart shows the different symbols of the parts of a circuit.

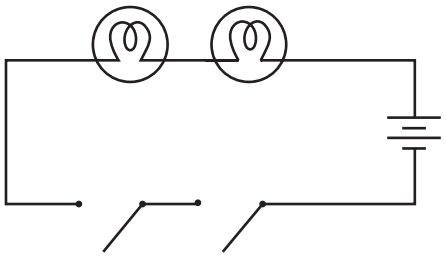
5. Look at the following circuit and identify what each letter represents.



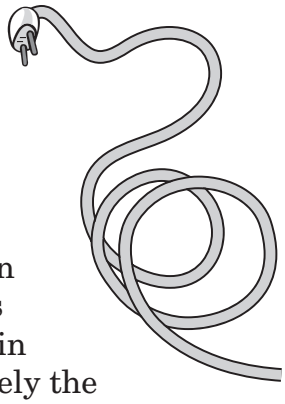
A ***load (light bulb)*** C ***energy source***

B ***switch*** D ***resistor***

6. Look at the diagram of the circuit on page 302 and draw a representation of it using the chart on page 312 of your textbook.



Resistance



Resistance is an important concept in electricity. If you like to watch police television shows, you have heard the statement – "He was resisting arrest." This means the person was trying not to get caught. He was **fighting** with the policemen to try to run away. **Resistance** in an electrical circuit has a similar meaning. It is a measure of how **freely** the electrons can flow in a circuit. The higher the resistance, the less freely the electrons can flow through the circuit. Resistance is measured in the units called **Ohms**.

A variety of factors can affect the resistance of a circuit. The type of material a wire is made of can affect resistance. This has to do with the conductivity of the material. For example, copper wire is a good conductor with a low resistance, whereas nichrome wire has a higher resistance. The thickness and length of a wire can affect resistance. A longer, thinner wire has more resistance than a short and thick wire. Just picture how traffic flows through a wide hallway in a school compared to a narrow hallway shortly after the lunch bell has rung.

Read pages 300 - 302 of *Science in Action 9*.

7. What is the relationship between resistance and conductivity?

   The higher the conductivity of a substance, the lower its resistance.

8. Explain why solutions can be resistors.

   Solutions can contain charged particles (electrolytes). They can conduct electricity but also provide some resistance to the current. A solution lacking electrolytes resists current flow.

9. What is an easy test to determine if bottled water is pure?

   Complete a conductivity test. If the water conducts electricity, then it is not pure.

10. Explain how a *rheostat* works as a resistor.

A rheostat can increase or decrease the amount of current passing through a circuit by adjusting the portion of the resistor that the current travels through.

Ohm's Law

One of the equations that you must learn to use is Ohm's law. Scientist Georg Ohm experimented with electricity to discover that as long as the temperature stays the same, the resistance of a conductor stays constant and the current is directly proportional to the voltage applied. Mathematically, Ohm's law can be understood as follows:

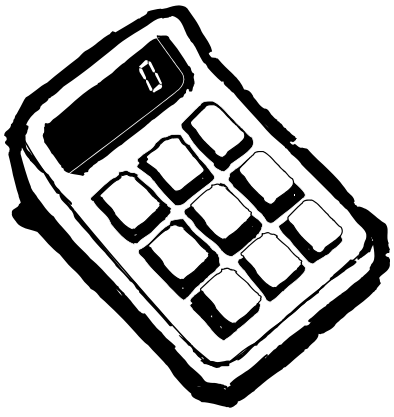
$V = I \times R$ (The voltage **V** is equal to the current **I** multiplied by the resistance **R**.)

This equation can also be manipulated to read

$I = \frac{V}{R}$ (The current **I** is equal to the voltage **V** divided by the resistance **R**.)

or

$R = \frac{V}{I}$ (The resistance **R** is equal to the voltage **V** divided by the current **I**.)



Here is a sample problem:

A lamp is connected to a 120 volt outlet. If the current flowing through the lamp is 16 amps, what is the resistance of the light bulb?

Problem-Solving Steps:

Step 1 **Identify the variables of the problem.**
What variables do you know, and what variable are you looking for?

V = 120 volts
I = 15 amps
R = ?

Step 2 **Identify the equation you need to use** and substitute the numbers into the variables.

$$R = \frac{V}{I} = \frac{120 \text{ volts}}{15 \text{ amps}}$$

Step 3 **Solve the problem and find the answer.**
(Use appropriate units.)

R = 8 ohms

Read pages 306-307 of *Science in Action 9*.

11. A 3.0 volt battery is connected in a circuit that has a resistance of 20 ohms. What is the current flowing through the circuit?

$V = 3 \text{ volts}$
$R = 20 \text{ ohms}$
$I = ?$
$I = \frac{V}{R}$
$I = \frac{3}{20}$
$I = 0.15 \text{ amps}$

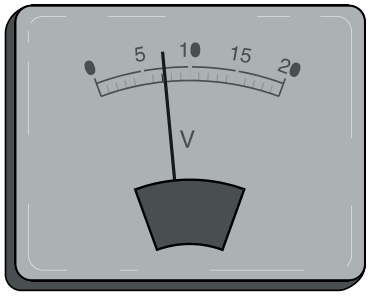
12. A circuit has an electrical current flowing at 25 amps. The resistance of the circuit is 15 ohms. How much voltage is flowing through this circuit?

I = 25 amps
R = 15 ohms
V = ?
V = I x R
V = 25 amps x 15 ohms
V = 375 volts

13. A household circuit has 120 volts. If a microwave that is plugged into it uses a current of 15 amps, what is the resistance in the circuit?

V = 120 volts
I = 15 amps
R = ?
$$R = \frac{V}{I}$$
$$R = \frac{120 \text{ volts}}{15 \text{ amps}}$$
R = 8 ohms

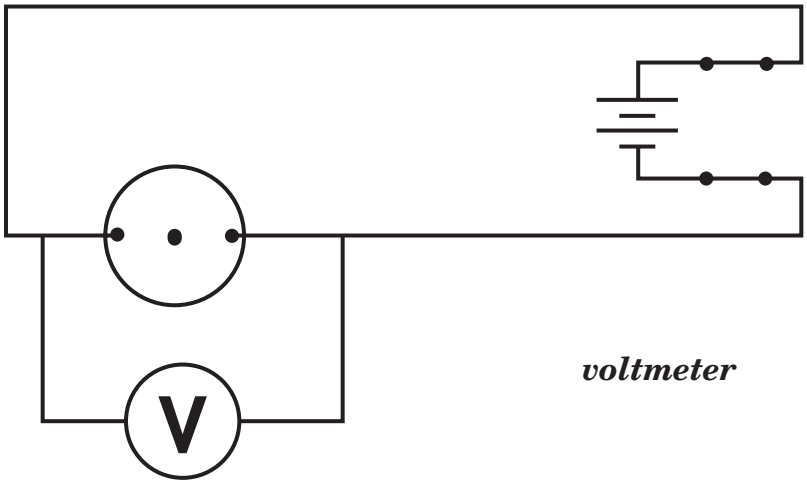
Testing Circuits



How does a person identify how much current or voltage is flowing through a circuit? A number of devices are available to test circuits. A **voltmeter** measures the amount of voltage in a circuit. The circuit must be connected to the positive and negative terminals of the voltmeter. **Millivoltmeters** can be used to measure small voltages in circuits. An **ammeter** is used to measure electrical current in a circuit in the unit of amperes. An ammeter must be connected so that the current flows through it. A **galvanometer** is used to measure small currents. A **multimeter** can be used to measure voltage, current, or resistance in a circuit. Remember that a unit of resistance is an ohm.

Read pages 307-309 of *Science in Action 9*.

14. A student wants to find the voltage in her remote control toy car. Using the diagram of the circuit below, identify what type of instrument she needs to use and where in the circuit it would need to go.

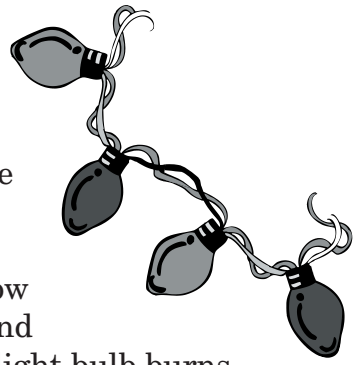


voltmeter

15. Explain how a surge protector works to protect your computer.

If the voltage flowing through the circuit is too high, the resistance of the conductor drops, drawing the dangerous extra current away from the computer on the normal circuit to a safety ground wire instead.

Types of Circuits



Circuits are divided into two categories: a series circuit or a parallel circuit. In a **series circuit**, only one pathway is available for the current to flow. (View figure 2.24 on page 313 of *Science in Action 9*.) Light bulbs in this type of circuit are placed in a row so that the current flows though each bulb and then to the other parts of the circuit. If one light bulb burns out, the rest of the light bulbs will not work. Also, when more components are added to the circuit, the total resistance of the circuit increases, which causes the current to decrease.

In a **parallel circuit**, more than one path is available for the electricity to flow. (View figure 2.25 on page 313 of *Science in Action 9*.). If a component such as a light bulb does not work, the remainder of the components still work. The lights you use to decorate your Christmas tree are placed in parallel circuits. When more components are added in this type of pathway, the resistance of the circuit decreases, which causes the current to increase._

Read pages 313 - 315 of *Science in Action 9*.

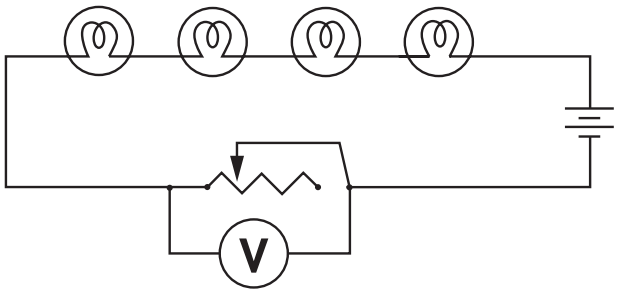
16. Outline an example of where series and parallel circuits are used.

An example of a series circuit is a switch and the light it controls. An example of a parallel circuit is the wiring between switches and plug-ins in your home. If you have two lights and the TV on the same circuit, they are parallel.

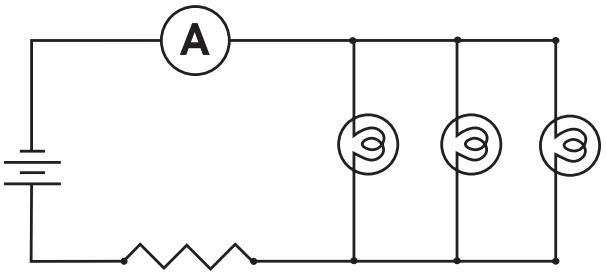
17. A series circuit contains three light bulbs. Explain what will happen to the brightness of each light bulb if two more bulbs are added to the circuit.

The amount of voltage decreases if another device is added to the circuit The bulbs will be dim.

18. Using the chart on page 312, draw a picture of a series circuit that contains four light bulbs, a rheostat, and a voltmeter.



19. Using the chart on page 312, draw a picture of a parallel circuit that contains three light bulbs, a resistor, and an ammeter.



20. What happens to the resistance in a parallel circuit when a new pathway is added?

The resistance decreases because there is a new path for the electrons to flow through.

21. What happens to the brightness of each light in a parallel circuit as more bulbs are added?

They stay as they were. They do not get dimmer as they would in a series circuit.

22. What is a microcircuit made of? How does it compare in size to a regular circuit. Where is this type of circuit used?

A microcircuit is made of microscopic transistors and resistors. It is very small. Some microcircuits contain 1 000 000 components in a square centimeter.

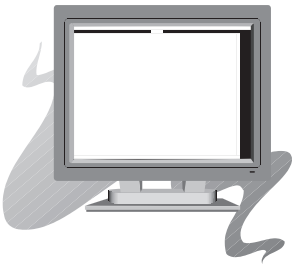
Microcircuits are used in computers.

Internet Websites

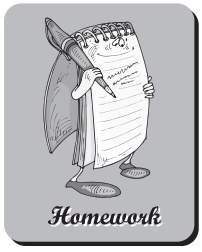
The addresses for the websites below were valid at the time of printing.

www.energyquest.ca.gov/story/chapter04.html

www.energyquest.ca.gov/story/chapter02.html



After finishing this lesson, you should have a better understanding of electrical circuits and how they work. To investigate circuits further, complete the following assignment.



Homework

23. Remember the scene at the beginning of the lesson where you were listening to music, making popcorn, and melting butter. Why did everything stop?

The current flowing through the circuit caused the switch in the circuit breaker box to shut off.

24. Find the main breaker panel in your home and look at the number of circuit breakers in use. Try to find out the size of the breaker switches (in amps) in it. Is there a variety? Why or why not?

In my house I have 24 separate circuit breakers. The majority of the breakers are 15 amps. The stove in our house is connected to a double circuit (two 40 amp) breaker.

25. Think about where you may find circuits. Make a list and try to identify as many locations as you can. You know that a computer has many circuits, for example.

Computers, calculators, telephones, appliances, vehicles, etc.