

Important Concepts . . .

Preview Review



Science

Grade 9

W1 - Lesson 2: Electrical Circuits

Important Concepts of Grade 9 Science

W1 - Lesson 1	Electrical Principles
W1 - Lesson 2	Electrical Circuits
W1 - Lesson 3A	Energy Consumption
W1 - Lesson 3B	The Distribution of Matter in Space
W1 - Lesson 4	Objects in Space
W1 - Lesson 5	Optical and Radio Telescopes
W1- Quiz	
W2 - Lesson 1	Physical and Chemical Properties of Materials
W2 - Lesson 2	Chemical Reactions
W2 - Lesson 3	Using the Periodic Table
W2 - Lesson 4	Naming Chemical Compounds
W2 - Lesson 5	Writing Chemical Equations
W2 - Quiz	
W3 - Lesson 1	Variation
W3 - Lesson 2	Reproduction and Patterns of Inheritance
W3 - Lesson 3A	Genes and Cell Division
W3 - Lesson 3B	Organisms and Matter in their Environment
W3 - Lesson 4	Biological and Chemical Monitoring/Acids and Bases
W3 - Lesson 5	Transfer of Materials through the Air, Ground, and Water/Biological Impacts of Hazardous Chemicals
W3 - Quiz	

Materials Required

Textbook:
Science in Action 9

Science Grade 9

Version 5

Preview/Review W1 - Lesson 2

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Preview/Review Concepts for Grade Nine Science



*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

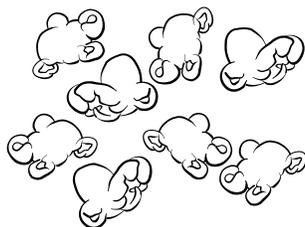
semiconductor - a material, such as silicon or germanium,

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?

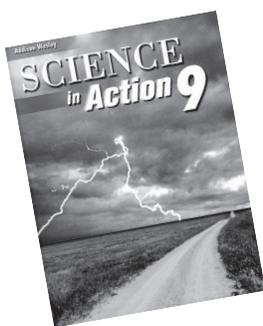
Circuit Design

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.



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

Silver	Germanium
Tap water	Distilled water
Gold	Neon gas
Mercury at absolute zero	Vinegar
Silicon	Copper

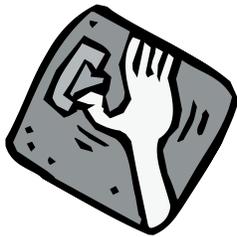
3. Read the materials and equipment list in the “Investigating Conductivity” lab on page 299 of your textbook.

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

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

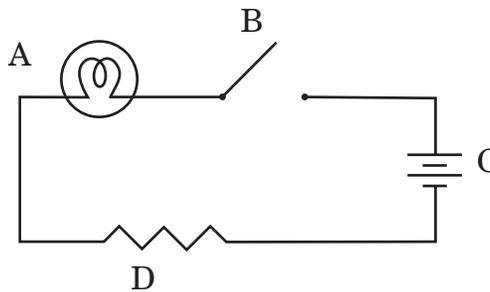
Safety mechanisms that electrical circuits in houses must have are fuses, circuit breakers, and ground wires in appliances that are plugged into the circuits. **Fuses** contain a thin metal that melts if the current passing through it is too high. A **circuit breaker** contains metal that will bend to 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.



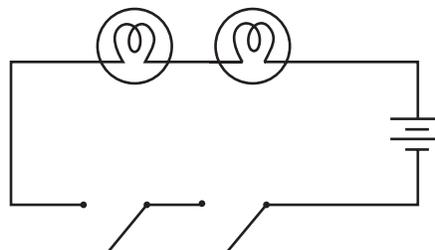
Learning to draw a representation of a circuit is part of learning about electricity. Look at page 312 of *Science in Action 9*. A chart shows the different symbols of the parts of a circuit.

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



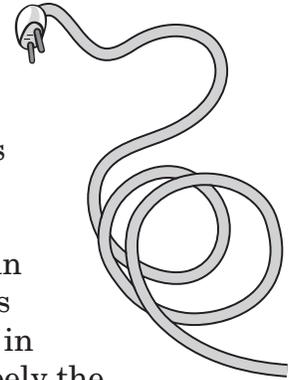
A _____ C _____
 B _____ D _____

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?

8. Explain why solutions can be resistors.

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

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

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

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

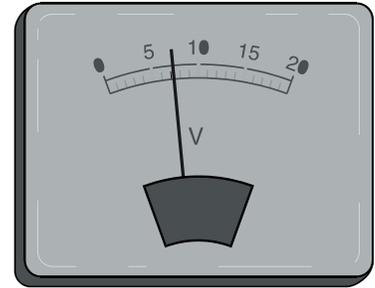
11. A 3.0 volt battery is connected in a circuit that has a resistance of 20 ohms. What is the current flowing through the circuit?

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?

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?

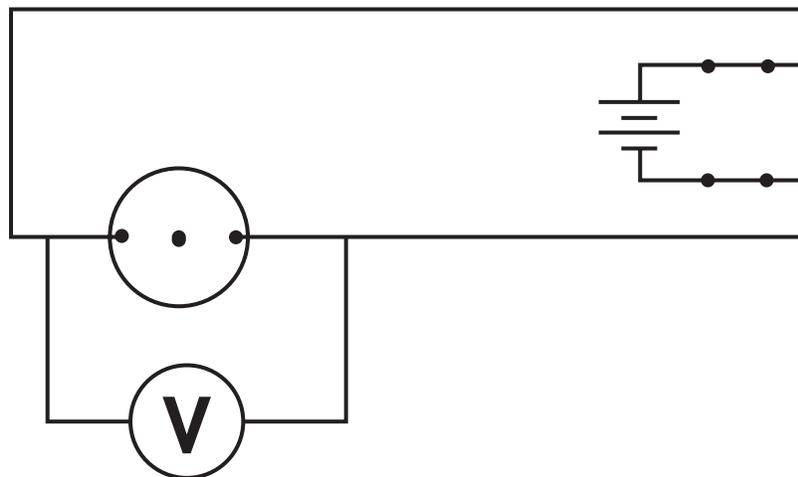
Testing Circuits

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*.

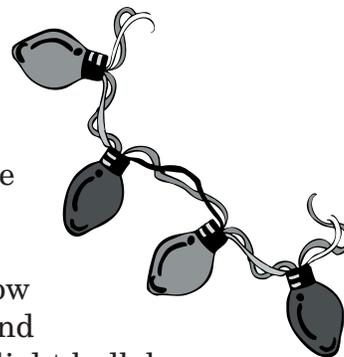
14. A student wants to find the voltage in her remote control toy car. Using the diagram of the circuit below, identify what type of instrument she needs to use and where in the circuit it would need to go.



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

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 through 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.



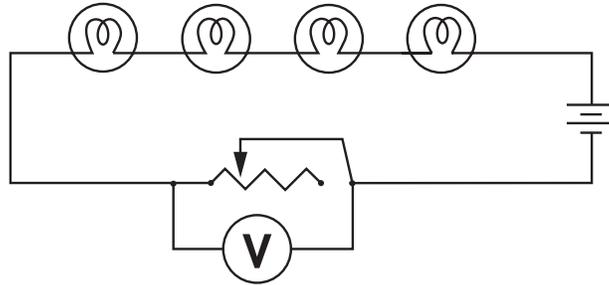
In a **parallel circuit**, more than one path is available for the electricity to flow. (View figure 2.25 on page 313 of *Science in Action 9*.) If a component such as a light bulb does not work, the remainder of the components still work. The lights you use to decorate your Christmas tree are placed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

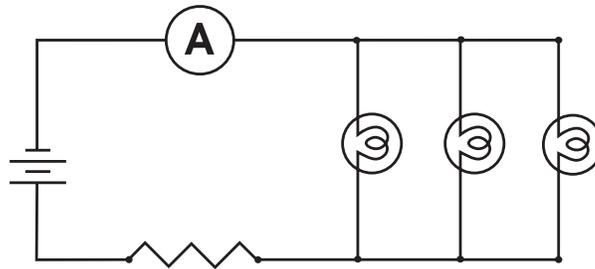
16. Outline an example of where series and parallel circuits are used.

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.

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?

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

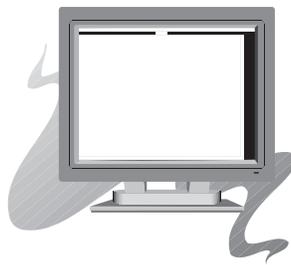
22. What is a microcircuit made of? How does it compare in size to a regular circuit. Where is this type of circuit used?

Internet Websites

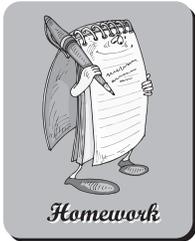
The addresses for the websites below were valid at the time of printing.

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?

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?

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.
