3 How Do Charges Flow through the Components of a circuit NEW

May 9, 2019 10:01 AM

science 9

UNIT 3 : PHYSICS

BOOK 3: HOW DO ELECTRIC CHARGES FLOW THROUGH COMPONENTS OF A CIRCUIT?

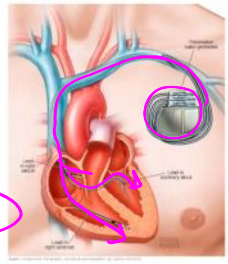
name: Key block: ______

①

3.3 How Do Charges Flow through the Components of a circuit?

FUN FACT

In 1950, Canadian Drs. Wilfred Bigelow and John Callaghan first used an external electrical device, developed by Dr. John Hopps, to pace the beating of a dog's heart. The device was the first pacemaker. Modern technology has brought the pacemaker a long way since those days. Pacemakers are used to help people with irregular heartbeats. As well, they are small enough to be surgically inserted under the skin on the chest. The electrical energy to run a pacemaker comes from a battery that lasts 10 years or longer. Electrical charges flow through the tiny electrical device, completing an electrical pathway called a circuit within the human body.



Part A Chemical Energy Separates Electrical Charges in Cells

What do a charged storm cloud and batteries have in common?
The both separate positive + negative charges.

Lightning is an uncontrolled burst of electrical energy and can cause power outages, injuries, loss of life, and fires.

A battery can provide a steady, controlled flow of electricity.

A battery is a combination of electrochemical **cells** connected together *(or a single electrochemical cell).*

Electrochemical cells convert chemical **energy** into electrical **energy** stored in charges. (potential)

Electrochemical cells are commonly called "cells" **or** batteries.

For example, an AA "battery" is an electrochemical cell.

In a cell, chemical reactions of two different metal or metal compounds occur on the surface of electrodes.

The electrodes (solid metals) are in a solution called an electrolyte (liquid part).

The reactions cause one electrode to become **positively** charged, and the other to become **negatively** charged.

Chemical energy separates the positive and negative charges.

The electrodes are in contact with terminals in the cell. (battery)

When terminals are connected to an electrical pathway charges flow through it.

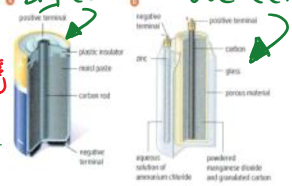


Figure 3.13 shows two types of cells. **A** Dry cell contains a moist paste as an electrolyte. In a Wet cell, the electrodes sit in a liquid solution.

Both transform **chemical energy** into **electrical energy** to run portable devices.

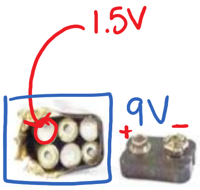


Figure 3.14 The battery shown here is made up of six individual cells.

In a battery a combination of electrochemical cells are connected together *(two or more).*

You make a battery when you place AA cells together in an electrical device. Often, devices require several cells to be packaged together in a casing to make a battery (Figure 3.14).

Cells and batteries are "sources". A source is anything that supplies electrical **energy**. Electrical outlets. are also sources.

How Does a Cell Work?

(+) → ← (−)

Because opposite charges attract each other, it takes energy to separate positive and negative charges.

In a cell, chemical reaction separate the positive and negative charges. In other words, chemical energy does the work of separating the charges. (← (+) away (−) →)

Recall that Energy is the ability to do work. Work is done on an object when a force acts on it, and makes it move through some distance

The worker carries electrons up a ladder and places them at the negative terminal. The worker leaves positively charged ions on the bottom at the positive terminal. The first electron is easy to carry up the ladder because only one pair of charges is being separated. The attraction is not very strong. Only a small amount of electrical energy is stored in the cell.

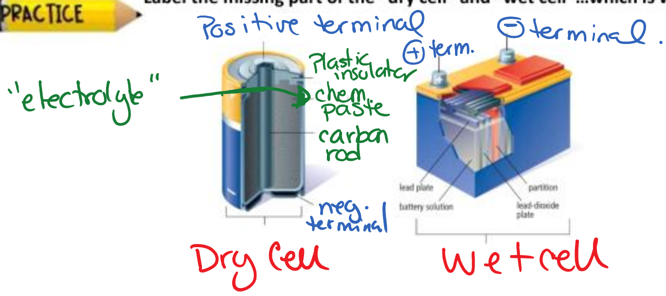
After a few charges have been separated, all of the positive charges of the positively charged ions at the positive terminal are attracting the negative charge of the electron that the worker is carrying. As well, the negative charges of the electrons at the negative terminal are repelling the negative charge of the electron that the worker is carrying. So it takes more energy to carry each additional electron up the ladder. The worker (chemical energy) has done a lot of work to separate the charges. This energy is now stored in the electrical potential energy of the separated charges.

Eventually, the repulsion of the electron by the negative charges and the attraction by the positive charges gets so strong that the worker cannot carry any more electrons up the ladder. No more chemical energy will be transformed into electrical energy.

(done by chemical energy) Because work went into separating the charges, the electrons now have the energy to do other work, such as running a fan or a watch. The electrical energy now stored in the cell is a form of potential energy. It has the potential to do work because of the separation or position of the charges.

If you stretch a spring and hold it, the energy in the spring is stored. This is an example of potential energy. The energy stored in the spring will not be released until you let go. Likewise, in order for the electrons to lose their stored electrical energy, the battery must be connected to a device. When you connect a battery to a light bulb, the electric potential energy is "released" as the electrons move through the wire inside the bulb and the electrons' energy is converted into heat and light energy.

PRACTICE **Label the missing part of the "dry cell" and "wet cell"…which is which?**



3

a device the battery is hooked up to.

Part B Electrical Potential Difference

A unit of charge, called a coulomb, gains electrical potential energy when it passes through a source, such as a battery. The amount of electric potential energy in one coulomb of charge is called the electric potential difference or voltage (V) which is measured in volts (V)

It is called a difference because it measures the difference in electrical potential energy per unit of charge between the positive terminal and the negative terminal in a cell./battery.

APE

height.

Figure 8.4 Even though the stairs are the same height in A and B, more work is done in B. Therefore, there is more potential energy in B.

You might compare potential energy and potential difference with climbing a staircase. When you climb a flight of stairs, your body has done work (Figure 8.4). The work you have done is now potential **energy**. If you had climbed the same set of stairs with a Big bag, you would have done MORE work. As a result, you and the backpack would have MORE potential energy. This means the potential energy depends on the height of the stairs and the amount of mass moved to the top.

You can think of the potential difference in a battery as being like the height **of the stairs**. The amount of charge separated in a battery is like the mass moved up the stairs.

The potential energy in the battery is due to both the potential difference *(volts)* and the amount of charge that has been separated *(coulombs)*. (how many ⊕ ⊖)

The amount of potential energy a battery can output (supply) depends not only on how much voltage the battery has but also on how much charge that battery can separate. Even though C, D, AA, and AAA batteries all have a potential difference of 1.5 V, the battery that can separate the most charge would have the greatest potential energy. The energy that charge possesses is dependent on the amount of charge and the voltage.

Cells and batteries are rated according to their electrical potential difference between one terminal and the other. Other sources, like electrical outlets, are rated in a similar manner.

The symbol and units for electrical potential difference are given below:

- The electrical potential difference is measured in volts (V)
- The symbol for electric potential difference is *V*

Because of its symbol and units, electrical potential difference is often called the voltage. For this reason the term voltage is frequently used on cells and batteries (Figure 3.16).

Figure 3.16 A typical AA or AAA cell provides an electrical potential difference of 1.5 V.

"voltage" = 1.5V

In the 1.5 V cell shown in the figure, it took 1.5 units of energy to carry that last unit of charge "up the stairs". If two cells are linked together, as in a flashlight or radio, their voltages ADD.

4

PRACTICE

1. How is chemical energy transformed into electrical energy in a cell?

   chemical energy (reactions in the electrolyte) separates (+) and (−) charges and builds up electric potential energy that is "released" when wires are connected and e⁻ flow (current)

2. Why is the electrical potential difference of a source called the "difference"? ("voltage")

   because it measures the difference in electric potential energy between the (+) and (−) terminals

3. If two 1.5 volt cells are placed in a radio, what is their voltage?

   1.5V + 1.5V = 3V

4. If six cells are packaged together to form a larger battery, what is the total voltage of the battery?

   6 × (1.5V) = 9V

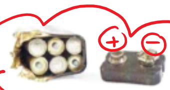


Figure 3.14 The battery shown here is made up of six individual cells.

Producing Voltage in Batteries

A __voltmeter__ is a device that measures the amount of potential difference between two locations of charge separation. When you place the connecting wires of a voltmeter across the __(+)__ and __(−) terminals__ of a battery, the voltmeter displays the battery's __voltage (V)__.

A battery has two terminals called __electrodes__ (metals). The electrodes are usually made of two different metals but can be a metal and another material. The electrodes are in an __electrolyte__, which is a substance that (⇒ ACIDS!) __conducts electricity__. Recall, that in a __dry__ cell, the electrolyte is a moist paste; in a __wet__ cell, the electrolyte is a fluid.

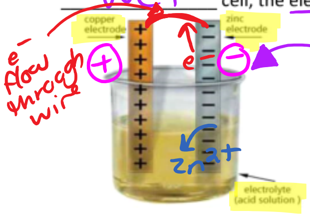


Figure 8.6 An electrochemical cell requires two different electrodes (usually metals) and an electrolyte.

Figure 8.6 shows an __electrochemical cell__ that uses a (liquid) zinc and a copper electrode. The acidic __electrolyte__ attacks the zinc electrode and pulls __Zn^{2+}__ off the zinc. When the zinc __gives (+) ions__ to the solution, it leaves __electrons__ behind on the electrode (metal), and the electrode becomes __negatively__ **charged**. This electrode is called the __ANODE (−)__.

At the same time, chemical reactions __pull e⁻ off__ the copper electrode. This makes the copper electrode have a __positive__ **charge**. This electrode is called the __CATHODE (+)__.

Because there is an __opposite__ **charge** on each electrode, there is a __potential difference__ (__voltage__) between the two electrodes.

5

The amount of voltage that is produced in an electrochemical cell depends on the types of metal and the acid solution (electrolyte.) used.

Most modern electrochemical cells can produce **1.5 V or 2.0 V.** For example, a 12 V car battery could consist of six 2.0 V cells or eight 1.5 V cells connected together.

PRACTICE

1. What device uses chemical energy to give charges electric potential energy?

   Battery

2. What is the definition of energy?

   The ability to do work

3. How is kinetic energy different from potential energy?

   → moving objects

   stored energy due to an objects position (height)

4. What is another name for electric potential difference?

   voltage

5. What two factors determine the energy the charge possesses?

   the energy a charge possesses is dependant on the amount of charge and voltage

6. What is the purpose of a voltmeter?

   to measure the

7. What are two groups of batteries?

   dry cell + wet cell

8. How is an electrode different from an electrolyte?

   metal +/- terminals

   → The liquid or dry paste (chemical) that separates charges.

6

HW

Reading About: Electric Potential Energy and Voltage pg 7-8

Complete the following reading about electric potential energy and voltage. Be sure to "Mark the Text" and highlight KEY DEFINITIONS as you read along.

ALSO, answer the "Reading Check" questions in the side margin as you go! ✔

Before You Read

Static electricity involves charges that build up and stay in the same place on an object. How could you store the charges to use later? Write down your ideas on the lines below.

Student answers will vary

Mark the Text

Identify Definitions

As you read this section, highlight the definition of each word that appears in bold type.

Reading Check

1. What is electric potential energy?

What is a battery?

Energy is the ability to do work—to make things move or change. A **battery** is a device that stores the energy in electric charges so that it can be used at some later time to do work. In other words, a battery is a source of **electric potential energy**—stored energy that has the potential to make something move or change.

Batteries convert chemical energy to electrical energy. For example, batteries that power a flashlight or a cordless mouse convert chemical energy to electrical energy. Batteries that convert chemical energy to electrical energy are called **electrochemical cells**, and may be wet cells or dry cells (see illustration). ✔

Reading Checks
Pages 110–111

1. stored energy that has the potential to make something move or change
2. potential difference

How does a battery provide energy?

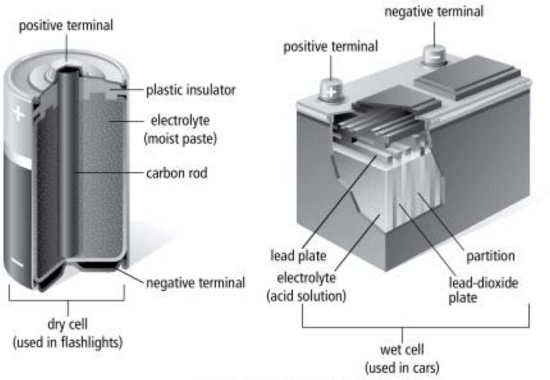
A battery provides energy to push negative charges through conductors that are connected together. Energy to push electrons is available if positive and negative charges are separated. In a flashlight battery, for example, energy from chemical reactions does the work of separating the charges.

A flashlight battery has two terminals called **electrodes** in a moist paste called an **electrolyte** that conducts electricity. Electrons build up at one terminal, making it negatively charged. At the same time, electrons withdraw from the other terminal, leaving it positively charged. Once the charges are separated, the charges have the ability to do work on something else, such as making a bulb light up.

What is voltage?

Scientists use the term **potential difference** to talk about the difference in potential energy per coulomb of charge between two points of an electric circuit. Potential difference is another name for **voltage**. The standard unit for voltage is the **volt** (V). The label 1.5 V on a battery means that it has a potential difference of 1.5 V. Voltage can be measured by a **voltmeter**.

Voltage is what causes charges to move. Think of a waterfall. The water in a waterfall naturally flows from a higher point to a lower point. In a similar way, charges naturally move from a higher level of energy to a lower level of energy. The difference in potential energy between one point in a circuit and another—the voltage—makes charges move in a circuit. ✔



Two types of batteries

✔ *Reading Check*

2. What is another name for voltage?

____

____

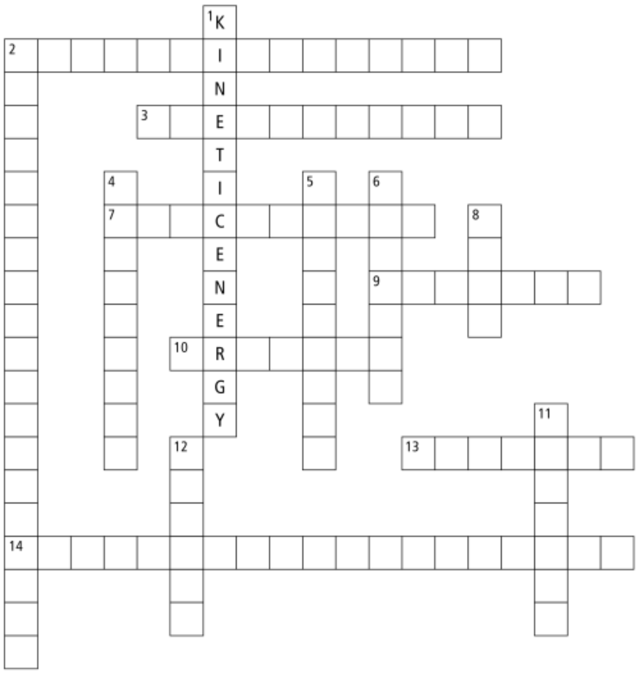
Reading Checks
Pages 110–111

1. stored energy that has the potential to make something move or change
2. potential difference

8

Homework **Assignment #1: Practice Worksheets pages 9-11**
Complete this assignment in the space provided below.

Electricity crossword puzzle



Across	Down
2. stored energy 3. electrodes are placed in a substance that conducts electricity 7. two terminals in a battery 9. unit for charge 10. battery in flashlights 13. amount of electric potential energy per one coulomb of charge 14. converts chemical energy into electrical energy	1. energy a moving object has 2. another name for voltage 4. positive and negative end points of a battery 5. device used to measure voltage 6. battery in cars 8. unit for potential difference 11. converts a form of energy into electrical energy 12. ability to do work

9

Answers

Vocabulary Puzzle
Electricity crossword puzzle
Page 112

Across
2. potential energy
3. electrolyte
7. electrodes
9. coulomb
10. dry cell
13. voltage
14. electrochemical cell

Down
1. kinetic energy
2. potential difference
4. terminals
5. voltmeter
6. wet cell
8. volt
11. battery
12. energy

Electric potential energy

Vocabulary	
battery	positively
chemical	potential difference
electrical	potential energy
electrochemical cell	removed
electrodes	separated
electrolyte	terminals
energy	volt
negatively	voltage

Use the terms in the vocabulary box to fill in the blanks. You may use terms more than once. You will not need to use every term.

1. The ability to do work is called ________________________.
2. A device that stores the energy in electric charges so that it can be used at some later time to do work is called a(n) ______________________________________ or ____________________________________.
3. Energy that is stored in a battery is called electric ________________________.
4. A battery that powers a flashlight converts ________________________ energy to ________________________ energy.
5. Energy to push electrons is available if positive and negative charges are ________________________.
6. In a flashlight battery, energy from ________________________ reactions does the work of separating the charges.
7. A flashlight battery has two terminals called __________________________________ in a moist paste called a(n) ____.
8. Electrons build up at one terminal, making it __________________________________ charged. At the same time, electrons withdraw from the other terminal, leaving it ________________________ charged.
9. _____________________________________, or voltage, is the difference in energy per coulomb of charge between one point in a circuit and another point in a circuit.

10

Answers

Cloze Activity

Electric potential energy

Page 113

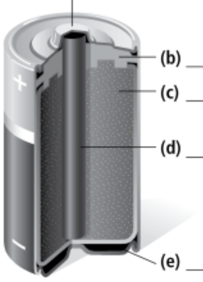
1. energy
2. Answers can be in either order: electrochemical cell, battery
3. potential energy
4. chemical, electrical
5. separated
6. chemical
7. electrodes, electrolyte
8. negatively, positively
9. potential difference

Electrochemical cells

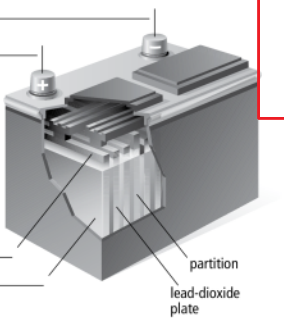
Use the following terms to label the two diagrams. You can use terms more than once. Some parts have been labelled for you.

Terms	
carbon rod	negative terminal
electrolyte	plastic insulator
lead plate	positive terminal

1.



2.



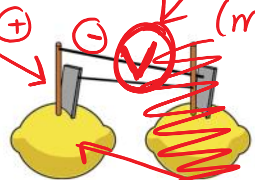
Answers

Electrochemical cells
Page 114

1. **(a)** positive terminal
   (b) plastic insulator
   (c) electrolyte
   (d) carbon rod
   (e) negative terminal
2. **(a)** negative terminal
   (b) positive terminal
   (c) lead plate
   (d) electrolyte

SCIENCE LAB

Lab Activity: Fruit Battery



SkillCheck

- Measuring
- Classifying
- Communicating
- Evaluating information

Safety

- Be careful of sharp edges when inserting the metal strips into the fruit.

Materials

- various fruits

In this investigation, you will determine the factors that produce potential difference in an electrochemical cell.

controls: - holes in lemon
- electrolyte (lemon)

Question

What materials are needed to make a voltage-producing electrochemical cell?

Procedure

Independant variable: types of metal
Dependant variable: voltage (measure with voltmeter)

Part 1

1. Give your data table a number and a descriptive title.

Table 1:

	Metal 2			
	Aluminum	Zinc	Iron	Copper
Aluminum				

strips into the fruit.

Materials

- various fruits
- 2 aluminum strips
- voltmeter
- 2 zinc strips
- 2 iron strips
- 2 copper strips
- steel wool
- 250 mL beaker
- water

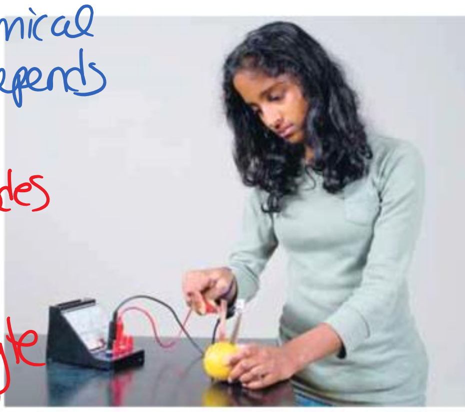
Metal 1	Aluminum	Zinc	Iron	Copper
Aluminum				
Zinc				
Iron				
Copper				

2. Select one piece of fruit. Carefully insert two aluminum strips into the fruit. The two metal strips should be about 2 cm apart and parallel to each other.

The amount of voltage an electrochemical cell can produce depends on:

(1) types of electrodes (metals)

(2) type of electrolyte (acid solution)



Step 3 Touch the leads from the voltmeter to the two strips.

1 2

Procedure Continued...

3. Touch the leads from the voltmeter to the two strips. You may find that the voltage fluctuates. Count 5 s from when you first started measuring the voltage. Record the voltage at 5 s in your data table.
4. Remove one of the aluminum strips from the fruit and insert the zinc strip. Be sure to use the same slit that the original strip was in. Repeat step 3.
5. Continue steps 3 and 4 until you have done all the combinations of metal strips and the data table contains all the measured voltages.

Part 2

6. Identify the combination of metals that produced the highest voltage. Wash the two strips so that there is no fruit juice on them. Use the steel wool to clean the strips. Fill a 250 mL beaker with 100 mL of clean water.
7. Place the metals identified in step 6 in the beaker of water. Place them so they are parallel and about 2 cm apart.
8. Connect the voltmeter to the two strips just as you did in step 3. Observe the reading on the voltmeter.
9. Clean up and put away the equipment you have used.

Analyze

1. In Part 1, what combination of metals produced the ***highest*** voltage?
2. In Part 1, what combination of metals produced the ***lowest*** voltage?
3. In general, how did the voltage produced by two similar metals in Part 1 compare to the voltage produced when the two metals were different types?
4. Why was it important to use the same openings in the fruit each time?
5. In Part 2, how did the voltage produced by the two metals in water compare to when the metals were in the fruit? Give a possible explanation for this result.

Conclusion

1. What materials are needed to produce a high voltage in an electrochemical cell?

charging by friction

Part C: Charges can Flow through Conductors, but not Insulators:

When two different solid materials are rubbed together, electrons can be transferred form one material to the other. The electrons will either stay on the surface of the new material or travel through it.

Any material that electrical charges can move through is called a conductor.

Electrons can move through almost all metals, but they move through some metals more easily than others.

How easily the charges move through a material is referred to as its conductivity

A material that charges cannot travel through at all is an insulator.

Look at Figure 3.17. Most electrical wiring is made out of metals that **conduct charges** very well, such as COPPER.

Most electrical cords and wires are covered with rubber or plastic. These materials are insulators

Most non-metals, such as glass, wood, are also insulators.

Figure 3.17 Electrical cords are made of a metal conductor covered by an insulator to prevent the charges from moving from one wire to the other. The insulator also prevents charges from moving to other objects, including you.

PRACTICE Explain why electrical wirers are covered by an insulator.

- safety - so you don't get shock
- to ensure e^- (electricity) gets to the source (not other ⊕ charges along the way)

Part D: Moving Electrical Charges form an Electric Current:

Charges can flow from a **source** through conducting materials to an appliance or an electrical device, such as a cellphone. (battery, electrical outlet.)

chemical energy from the source causes charges to move through the conductor, usually wires, carrying energy to the device.

The moving charges are called an electric current.

The symbol for current is I and is measured in units called amperes (A) "amps"

For example, the equation I= 3 A means that the current (I) is 3 amperes (3A).

The smaller unit of electric current is the milliampere (IA = 1000 mA).

14

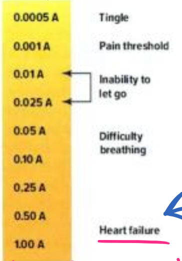
PRACTICE What is the *relationship* between moving charges and current?

moving charges (e- flowing) is electric current.

Effects of Voltage and Current on the Human Body

The scale on the right shows how the effects of current on the human body vary with the amount of current that flows through the body. The voltage is 120V, the **standard household voltage.**

small current



Large current

Study the scale and then research & answer the questions below.

1. Find out what the electric current is in homes in B.C. What type of caution does the scale on the right suggest that you should take around household currents? Justify your response.

100 - 200 A to a house
~1.5V per outlet.
(10-20A max at each outlet).

2. Electric current is used in some medical applications to treat health problems. Find out more about these applications and choose one that interests you. How does the treatment work? What kind of voltage and current is involved?

examples
- defibrillator (AED)
- pacemaker
- TENS machine - muscle/nerve stimulation.

15

Part E: A Load resists the Flow of Current

Any device that transforms electrical energy into other forms of energy is called an electric load.

As electrons pass through a load, they lose energy as electrical energy is converted into another type of energy.

Some examples of a load are a **light bulb**, a **buzzer**, a **heater**, and a **motor**.

A load **resists**, or hinders, the **flow** of current. This happens because the electrons in the current **collide**

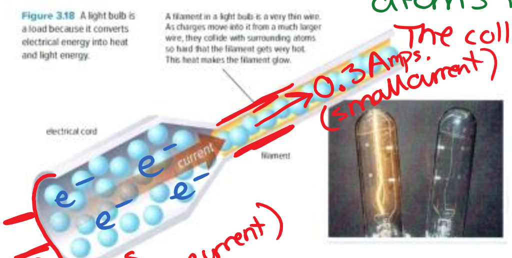


Figure 3.18 A light bulb is a load because it converts electrical energy into heat and light energy.

A filament in a light bulb is a very thin wire. As charges move into it from a much larger wire, they collide with surrounding atoms so hard that the filament gets very hot. This heat makes the filament glow.

The collisions interfere with the **flow of the current**.

How much the flow of current is hindered is referred to as **resistance** (R), and the units used to measure resistance is the **ohm**.

The symbol for an ohm is the Greek letter omega, Ω

The filament in a light bulb is a good example of **resistance** to the flow of **charges**.

Figure 3.18 shows how resistance makes a filament-type light bulb light up. As **charges** move into the filament (load) from a much larger wire, they **collide so hard** the filament gets very **hot**, and creates a glow and light energy.

Part F: Conductors must form a Closed Loop to allow Current to Flow

When a source, load, and conductor are connected in a way that allows **current to flow**, it is called an **electrical circuit**. In order for current to flow, a circuit must form a **closed loop**.

Figure 3.19 shows the simplest possible circuit having only a source and a load.

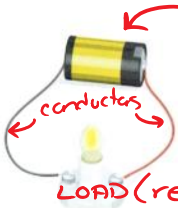


Figure 3.19 A closed loop allows current to flow and light the bulb. Short circuits can be dangerous if they occur in the wiring of a building. Suggest how a short circuit might form in a building.

Without a load to resist the flow of current, the current would be so **large** that the conductor would quickly get **very hot** and start a **fire**.

This is called a **short circuit**. Show circuits are fire hazards if they occur within a buildings wiring. This occurs when the resistance is too low, so the current flowing is so high it is dangerous.

what happens in a circuit

Figure 8.8 illustrates a simple **circuit** containing a battery, conducting wires, and a buzzer.

Chemical energy in the **battery** gives the electrons on the negative **terminal electric potential energy**. These electrons are **attracted to** the positive terminal of the battery. Electrons leave the negative terminal and are pushed by (repelled.) the energy from the battery through the **conducting wires** to the buzzer. In the buzzer, the electrons' electric potential energy is **transformed into sound** energy. Electrons travel back to the **battery** through the complete circuit.

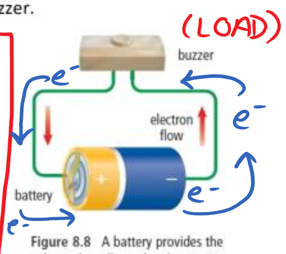
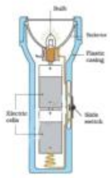


Figure 8.8 A battery provides the voltage that allows the electrons to travel through the circuit.

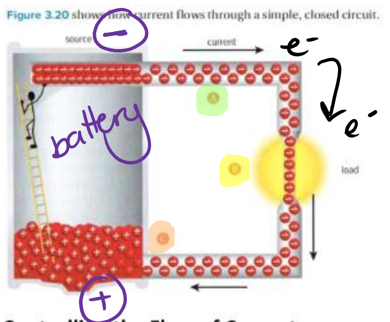
PRACTICE Use the terms: source, current, and load to describe how you think a flashlight works? *(use the diagram to help you)*



Chemical energy in the battery converts electric potential energy into light energy. The electrons flow **(current)** away from the negative terminal of the battery **(source)** and through the filament in the light bulb **(load)** where they collide and get hot which creates the glow and light energy. The electrons then flow back to the positive terminal because they are attracted to the + charge.
The switch will "open" and "close" the circuit...so when the flashlight is "off" means the switch is open, so current CAN NOT flow through the circuit.

Modelling the Flow of Current: *(an analogy)*

Figure 3.20 shows how current flows through a simple, closed circuit.



A.

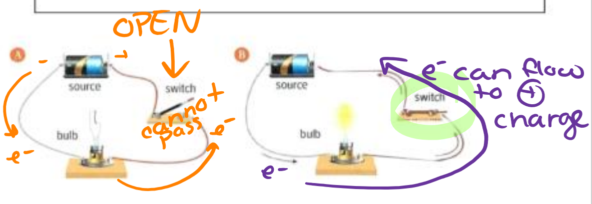
A The conductors already have electrons in them. The negative terminal repels the negative charges in the conductor; the positive terminal attracts them. As a result, electrons move along the conducting wires, and electrons from the cell move into the conductor.

B As the electrons pass through the load, they transfer some of their energy to the load. They then leave the load and return to the cell.

C Electrons enter the cell and combine with positive ions to become neutral. Over time, there are fewer electrons at the negative terminal and fewer positive ions at the positive terminal. The worker can carry more electrons up the ladder, keeping the number of separated charges equal at all times.

Controlling the Flow of Current:

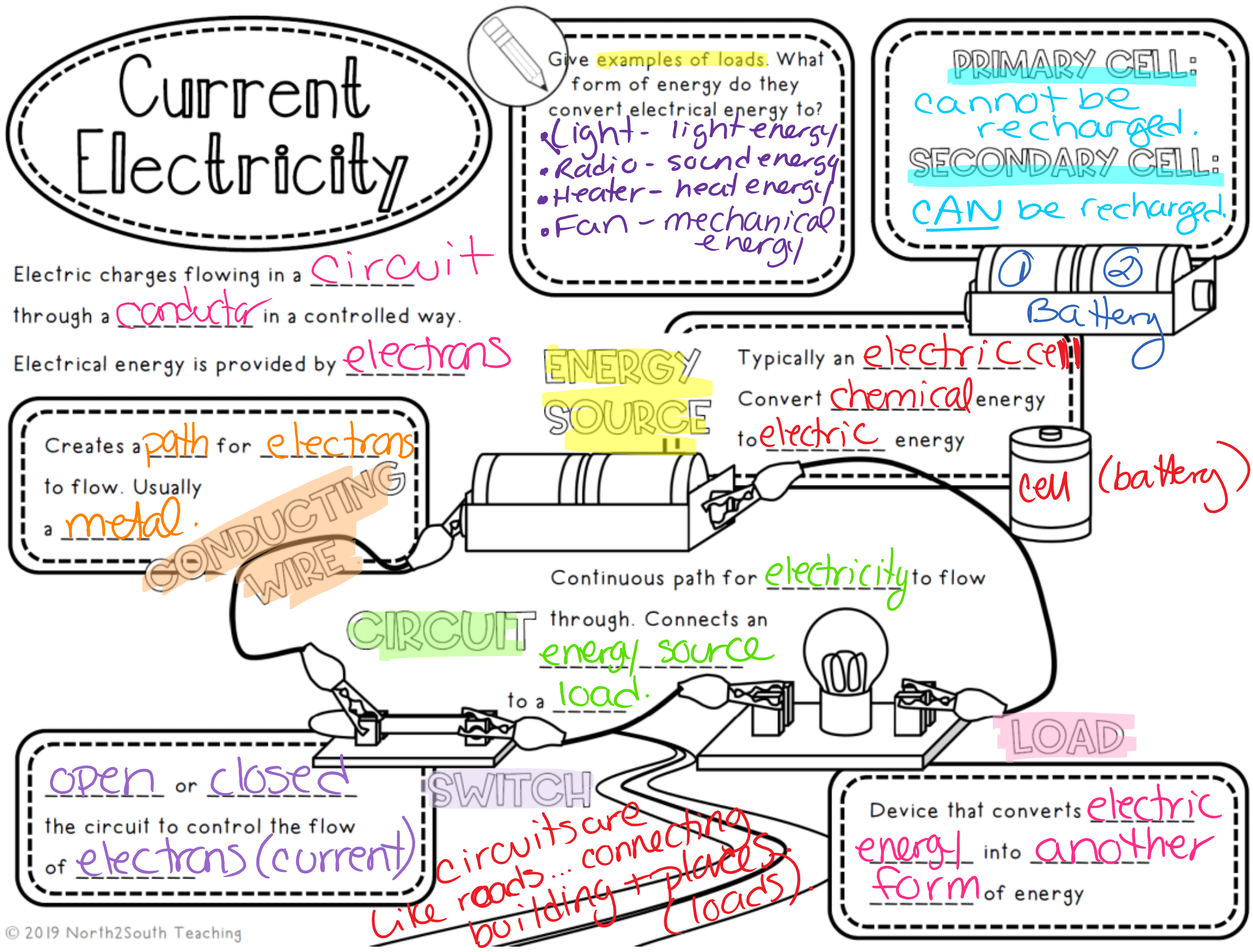
In a typical circuit, a **switch** lets you "open" and "close" the circuit to the flow of current.



A The switch is open. There is no closed path so the current cannot flow. The circuit is open.

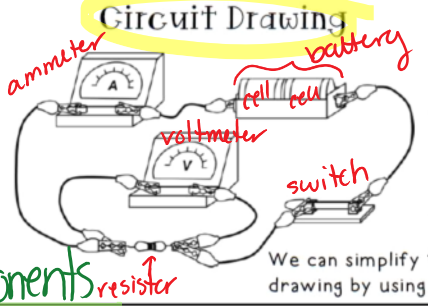
B The switch is closed, allowing current to flow and the light to be on. The circuit is referred to as closed.

17


Current Electricity
Electric charges flowing in a circuit
through a conductor in a controlled way.
Electrical energy is provided by electrons
Give examples of loads. What form of energy do they convert electrical energy to?
• Light - light energy
• Radio - sound energy
• Heater - heat energy
• Fan - mechanical energy
PRIMARY CELL: cannot be recharged.
SECONDARY CELL: CAN be recharged.
① ② Battery
ENERGY SOURCE
Typically an electric cell
Convert chemical energy
to electric energy
cell (battery)
Creates a path for electrons
to flow. Usually
a metal.
CONDUCTING WIRE
Continuous path for electricity to flow
through. Connects an
energy source
to a load.
CIRCUIT
LOAD
open or closed
the circuit to control the flow
of electrons (current)
SWITCH
circuits are like roads... connecting building + places (loads).
Device that converts electric
energy into another
form of energy
© 2019 North2South Teaching

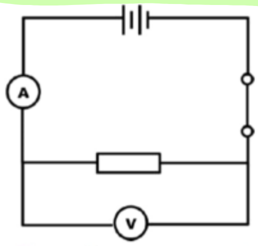
Circuit Diagrams

Circuit Drawing



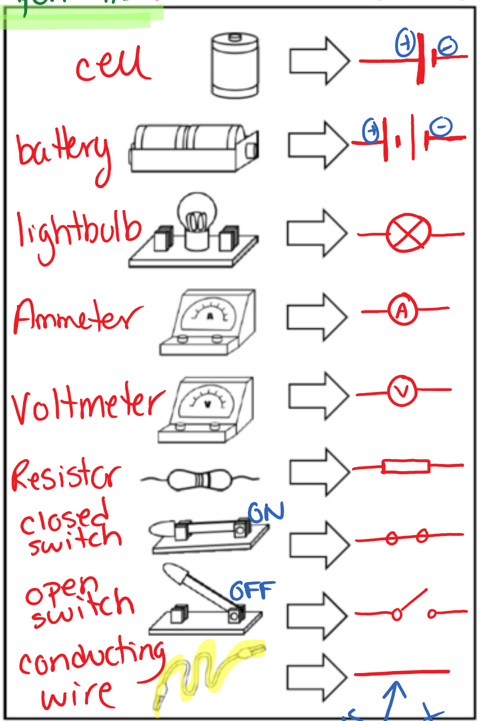
We can simplify this drawing by using symbols

Circuit Diagram

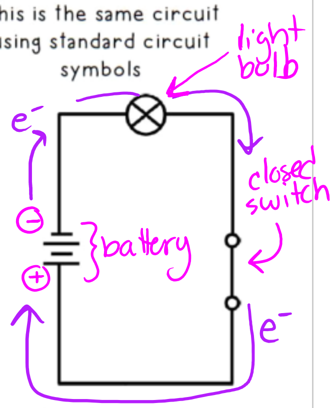


This is the same circuit using standard circuit symbols

Components

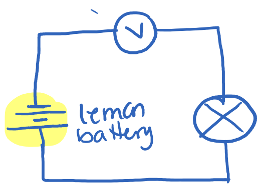


Electrons flow from negative terminal to positive terminal



Try it!

Draw and label a circuit diagram with at least three components using circuit diagram symbols.



19

always draw straight lines

Part G: Circuit Diagrams

Even the most complex circuits are made of only four basic types of parts or components:

- **Source:** the source of electrical energy (power outlet, battery, cell)
- **Conductor:** the wire through which electric current flows (metal wires covered in plastic or rubber)
- **Load:** a device that transforms electrical energy into other forms of energy (light bulb, radio, fan, toaster)
- **Switch:** a device that can turn the circuit on or off by closing or opening the circuit CLOSED = "ON" OPEN = "OFF"

Suppose that you needed to have someone build an electrical circuit for you.

Circuit diagrams are diagrams that use **symbols** to represent the different **components** of the circuit.

Table 3.1 Symbols for Circuit Diagrams

Component		Symbol	Quantity	Unit of Measurement
Source	Cell		Electrical Potential Difference (V)	Volt (V)
	Battery			
Conducting Wire			Current (I)	Ampere (A)
Load			Resistance (R)	Ohm (Ω)
Switch	Open			
	Closed			

Note: The long line in the symbols for cells or batteries represents the positive terminal and the short line represents the negative terminal.

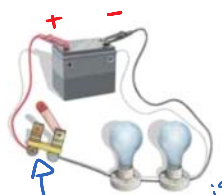
Circuit diagrams give an organized representation of the actual circuit.

In order to make your circuit diagrams simple to read, be sure to meet the following criteria:

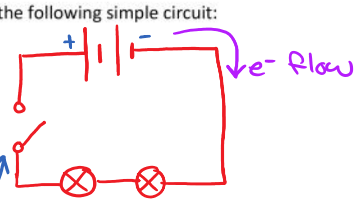
- Draw your diagrams using a ruler.
- Make all connecting wires and leads straight lines with 90º (right-angle) corners.
- If possible, do not let conductors cross over one another.
- Your finished drawing should be rectangular or square.

PRACTICE

Draw a circuit diagram for the following simple circuit:



switch is open



would the bulbs be lit up?

NO

20

PRACTICE Drawing Circuit Diagrams

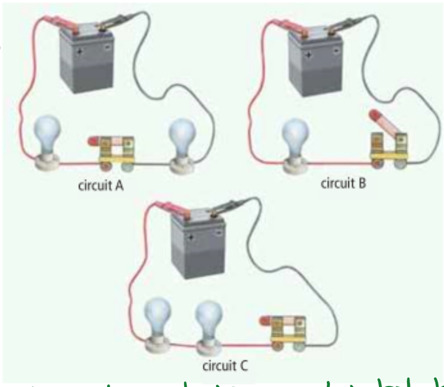
In a **closed circuit**, there can be no breaks in the path of electrons.

An **open circuit** does not allow a flow of electrons because there is a break in the path.

In this activity, you will draw and analyze circuit diagrams and decide which are open and which are closed.

What to Do

1. For each of the following circuit illustrations, draw its corresponding circuit diagram in the space provided below.



What Did You Find Out?

1. Which circuit(s) are closed circuits?

A and C

2. Which circuit(s) are open circuits?

B

3. In any of your closed circuits, identify the device that

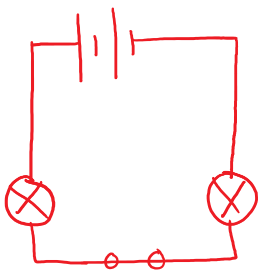
(a) is the source of electric potential energy

battery

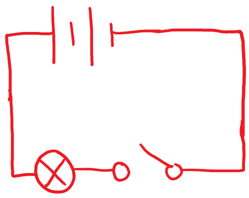
(b) converts the electrical energy to other foms

Load (in this case the Load is a Light bulb converting electrical energy into Light energy)

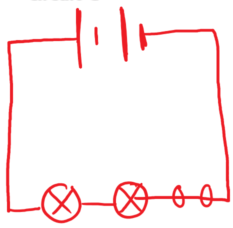
circuit A



circuit B



circuit C



READING ABOUT: ELECTRIC CURRENT PG 21-22

STOP & READ THIS!

Complete the following reading about electric current. Be sure to "Mark the Text" and highlight KEY DEFINITIONS as you read along.

ALSO, answer the "Reading Check" questions in the side margin as you go!

Before You Read

What is needed for a light bulb to light up? Write your ideas on the lines below.

energy source (battery, power outlet), conducting wires, maybe a switch.

Mark the Text

Check for Understanding

As you read this section, be sure to reread any parts you do not understand. Highlight any sentences that help you develop your understanding.

Reading Check

1. What is an electric circuit?

Answers

Reading Checks
Page 116
1. a complete pathway through which electrons can flow
2. ammeter

Reading Check

2. What is the name of the device used to measure electric current?

What is needed for charges to move through an electric circuit?

A continuous movement of charge through a conductor is called **current electricity**. A complete pathway through which electrons can flow is called an **electric circuit**. An electric circuit has the following basic parts:

- There must be a *source* of electrical energy. This may be a battery or a wall outlet.
- There must be a *conductor* through which charges can move. This is usually a metal wire.
- There must be a device, called a *load*, which converts electrical energy into other forms of energy such as light or sound. Light bulbs, speakers, heaters, and motors are examples of loads.
- There may be a *switch*—a device that can control the movement of charges in the circuit by turning it on (closing the circuit) or turning it off (opening the circuit).

What is electric current and how is it measured?

An electrical source such as a battery provides energy to push negative charges through the conducting wires in a circuit. This movement of charge is called *current*. **Electric current** is the amount of charge that passes a point in a conducting wire each second.

Electric current is measured in units called **amperes** (A). A current of one ampere (1.0 A) is produced when 1.0 C (coulombs) of charged particles move past a point in a circuit each second. Electric current is measured with a device called an **ammeter**.

What does an electric circuit look like?

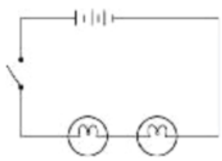
The parts of a circuit can be drawn with symbols to show how the circuit is connected. A picture that is made using these symbols to represent an actual circuit is called a **circuit diagram**.

Examples of symbols used in circuit diagrams:

conducting wire	bulb
+ − cell	open switch
+ − battery	closed switch
voltmeter	ammeter

A

B



This circuit diagram (B) shows the parts of the circuit (A).
Find each of the objects from circuit A in circuit B.

Assignment #2: Practice Worksheets pages 23-25
Complete this assignment in the space provided below.

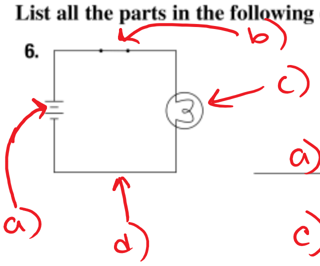
Identifying circuit symbols

Match the Term in the first column with the correct Illustration and Circuit Symbol in the other two columns. Place the corresponding letter and Roman numeral in the blank spaces provided.

Term	Illustration	Circuit Symbol
1. bulb C IV	**A.** 	**I.**
2. battery B V	**B.** 	**II.** 
3. open switch D II	**C.** 	**III.**
4. closed switch E I	**D.** 	**IV.** 
5. conducting wire A III	**E.** 	**V.** 

List all the parts in the following electrical circuit.

6.



a) battery b) closed switch

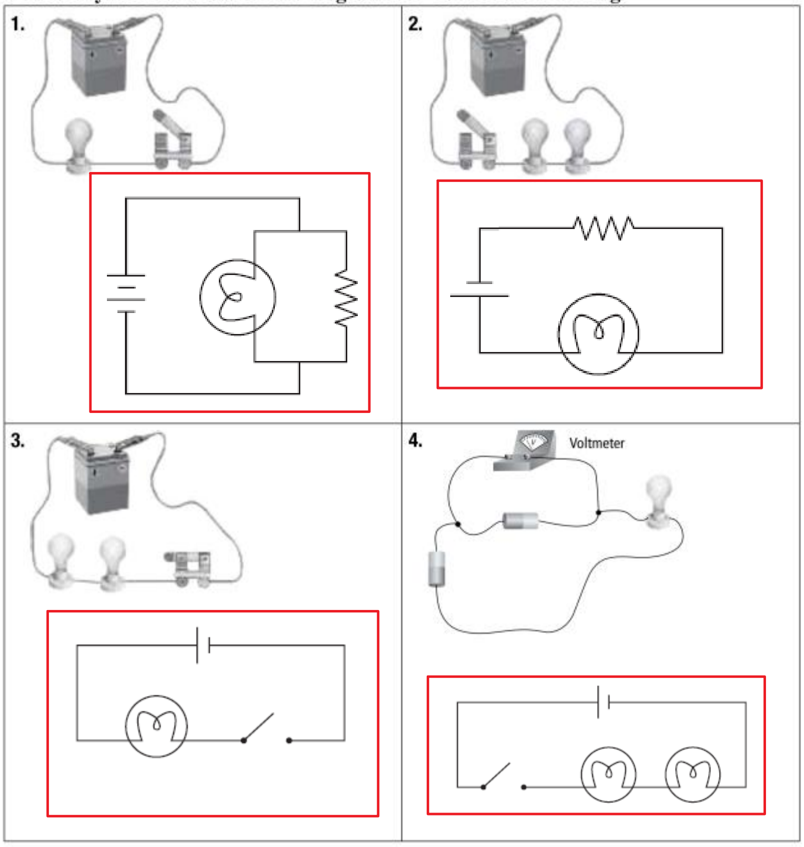
c) bulb d) conducting wire.

23

Key

Drawing circuit diagrams

Use circuit symbols to draw circuit diagrams for each of the following.



True or false?

Read the statements given below. If the statement is true, write "T" on the line in front of the statement. If it is false, write "F" and rewrite the statement to make it true.

1. _____ An electric circuit is a complete pathway through which electrons can flow.

____

2. _____ An electric load transforms light energy into electrical energy.

____

3. _____ Light bulbs, heaters, and batteries are all examples of electric loads.

____

4. _____ The wire through which electric current flows is a conductor.

____

5. _____ A switch is the source of electric potential energy in a circuit.

____

6. _____ Circuit diagrams use circuit symbols to illustrate actual electrical circuits

____

7. _____ Current electricity is charge that remains stationary on an insulator.

____

8. _____ Electric current is the amount of charge passing a point in a conducting wire each second.

____

____

9. _____ Electric current is measured in volts.

____

10. _____ An ammeter is used to measure the current in a circuit.

____

Answers:

True or false?
Page 120

1. True
2. False. An electric load transforms **electrical energy into other forms of energy.**
3. True
4. True
5. False. A switch is a **device that can turn the circuit on and off by closing or opening the circuit.** *or* A **battery** is the source of electric potential energy in a circuit.
6. True
7. False. Current electricity is the **continuous flow of charge in a complete circuit.** *or* **Static electricity** is charge that remains stationary on an insulator.
8. True
9. False. Electric current is measured in **amperes.** *or* Potential difference (voltage) is measured in volts.
10. True