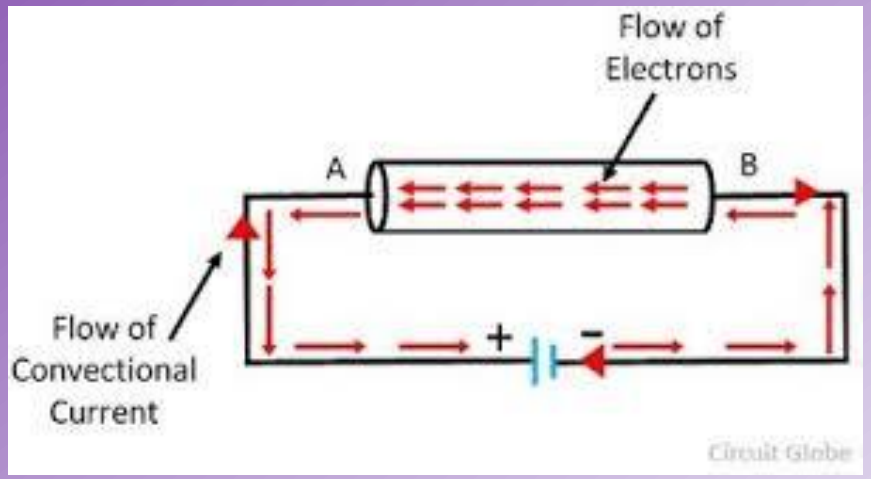
Current Electricity

- **Current electricity** refers to electric charges flowing in a circuit through a conductor in a controlled way

- **An Electric Circuit** is a continuous path for electricity to flow through



Flow of electricity

- Electricity flows along a conductor from an energy source, such as a battery, to a device that uses the energy

Battery: A Connection Of Two or More Electrochemical Cells

Battery: A connection of two or more electrochemical cells

- Example: Several electrochemical cells can be packaged together to make a battery

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

Chemical energy separates electrical charges in cells.

Electrochemical cell:

- Transforms chemical energy into electrical energy
- Example: An AA “battery” is an electrochemical cell (even though it is commonly known as a “battery”)

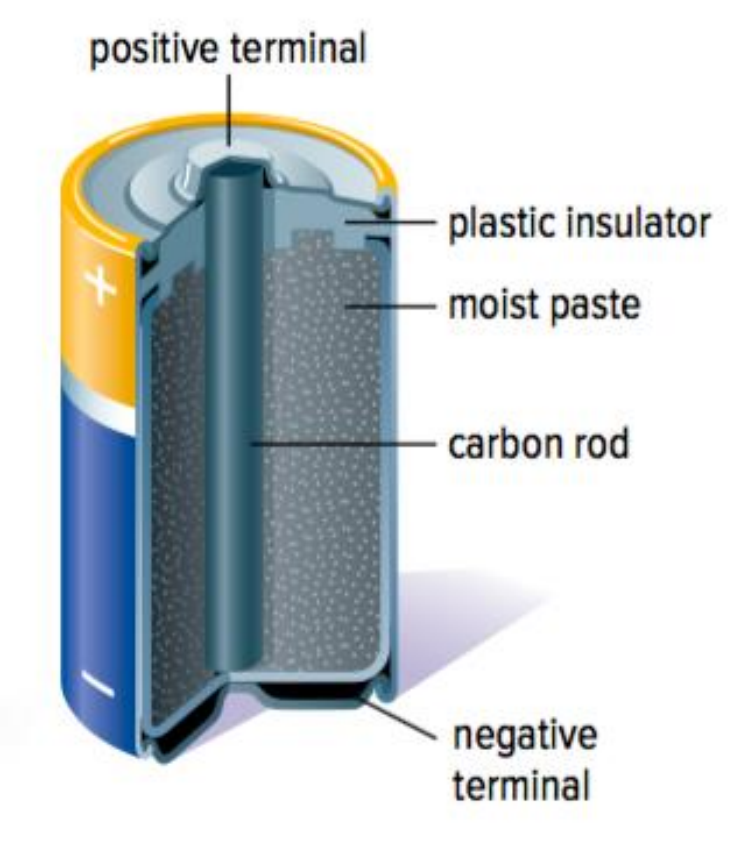


Figure 3.13: A dry cell (electrolyte is a paste)

How an Electrochemical Cell Works

- Chemical reactions of two different metals or metal compounds occur on the surface of *electrodes*
- The chemical reactions cause one electrode to become positively charged, and the other to become negatively charged
- The electrodes are in contact with terminals in the cell
- When the terminals are connected to an electrical pathway, charges flow through

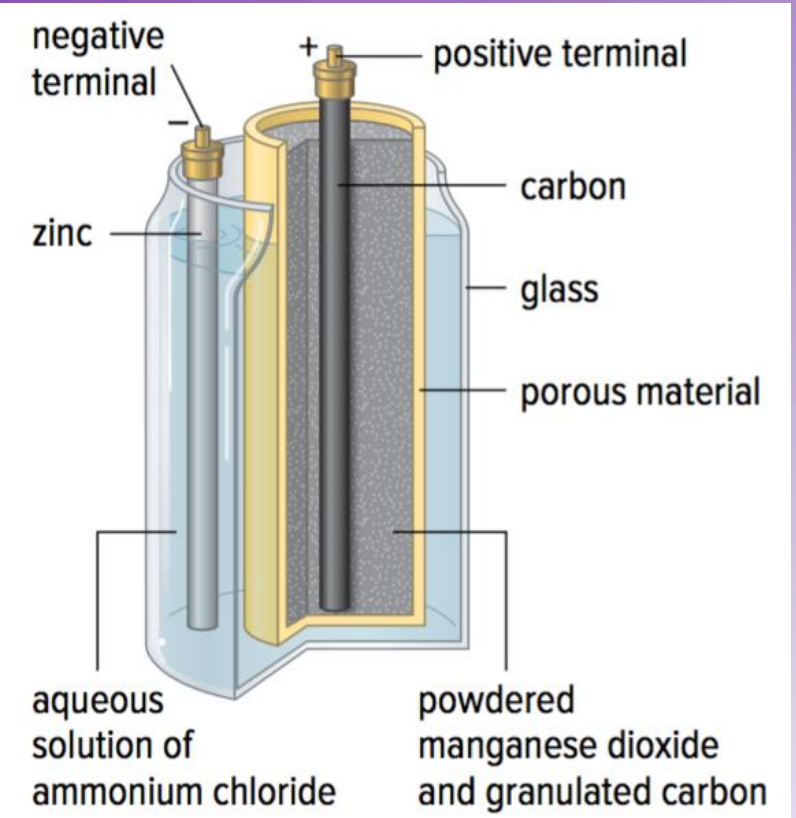


Figure 3.13: A wet cell

Source

- Source: anything that supplies electrical energy
  - Electrochemical cells
  - Batteries
  - Outlets

Electrical Potential Difference

A unit of charge gains electrical potential energy when it passes through a source (such as a battery)

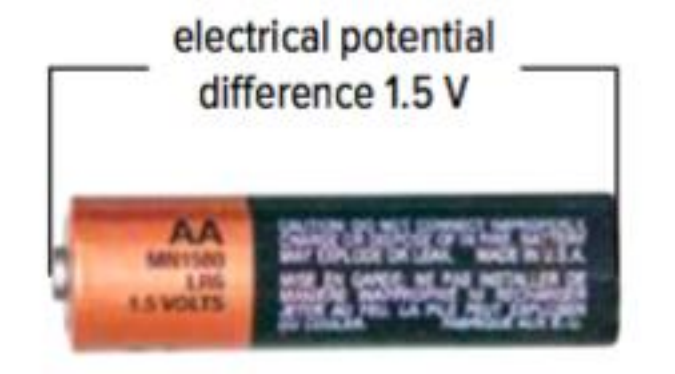


Figure 3.16: A typical AA or AAA cell provides an electrical potential difference (voltage) of 1.5V.

Electrical potential difference: A quantity that provides a measure of the electrical potential energy a unit of charge gains when passing through a source

- Often called voltage
- Symbol: *V*
- Units: volts (V)

Electrical Potential Difference (continued)

Why is electrical potential difference called a *difference*?

- It measures the difference in electrical potential energy per unit of charge between the positive terminal and the negative terminal in an electrochemical cell

Electrical potential difference is often called the voltage

- 1.5V cell: It took 1.5 units of energy to separate the last unit of charge

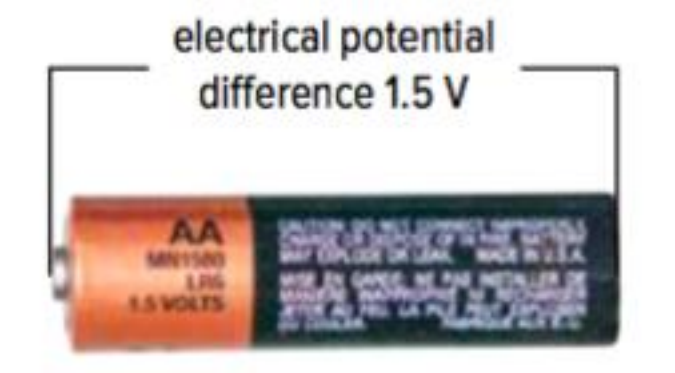


Figure 3.16: A typical AA or AAA cell provides an electrical potential difference (voltage) of 1.5V.

Discussion Questions

1. Why is the electrical potential different of a source referred to as a difference?

Charges can flow through conductors, but not insulators.

When two different solid materials are rubbed together, electrons can be transferred from one material to the other

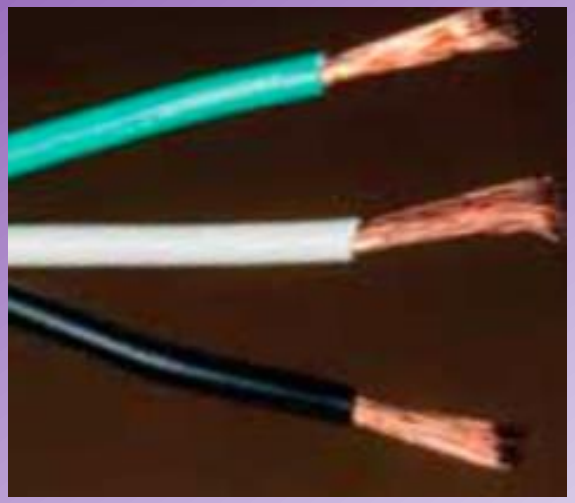
- Electrons with either stay on the surface of the new material or travel through it
- **Insulator**: A material charges cannot travel through
- **Conductor**: A material charges can travel through

Figure 3.17: Electrical cords are made of a metal conductor covered by an insulator to prevent charges from moving to other objects, including you.

Conductivity: How Easily Charges Travel Through a Material

Conductivity: An indication of how easily charges travel through a material

- Electrons can move through almost all metals (conductors); can move through some metals more easily than others
- The higher the conductivity of a material, the more easily electrons can move through



Discussion Questions

1. Explain why electrical wires are covered by an insulator.

Moving electrical charges form an electric current.

Chemical energy from a source (cell or battery) causes charges to move through a conductor (wires), carrying energy to an electrical device (cellphone)

- The moving charges are called an electric **current**
- Symbol for current: *I*
- Current is measured in amperes: A

Discussion Questions

1. Describe the relationship between moving charges and electric current.

A load resists the flow of current.

Load: A device that converts electrical energy into another form of energy

- As electrons pass through a load, they lose energy as electrical energy is converted to another type of energy
- Light bulb: A load that transforms electrical energy into light energy
- Radio: A load that transforms electrical energy into sound energy

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

Load: Resists The Flow of Current

A load resists (hinders) the flow of current

- Electrons in the current collide with atoms that make up the load, or with each other
- Collisions interfere with the flow of current

Resistance Describes The Amount of Current Hindered By a Load

Resistance: Describes the amount that current is hindered by a load

- Symbol: *R*
- Units: Ω (Ohm)

- Example of Resistance: Filament in a Light Bulb

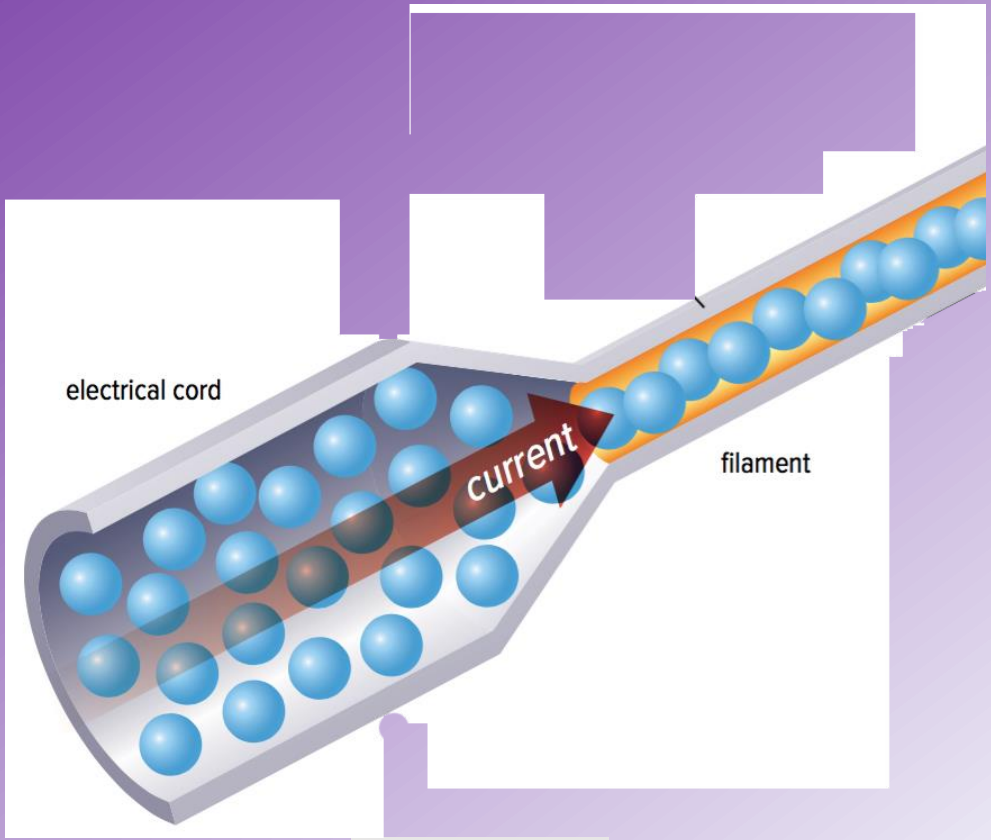
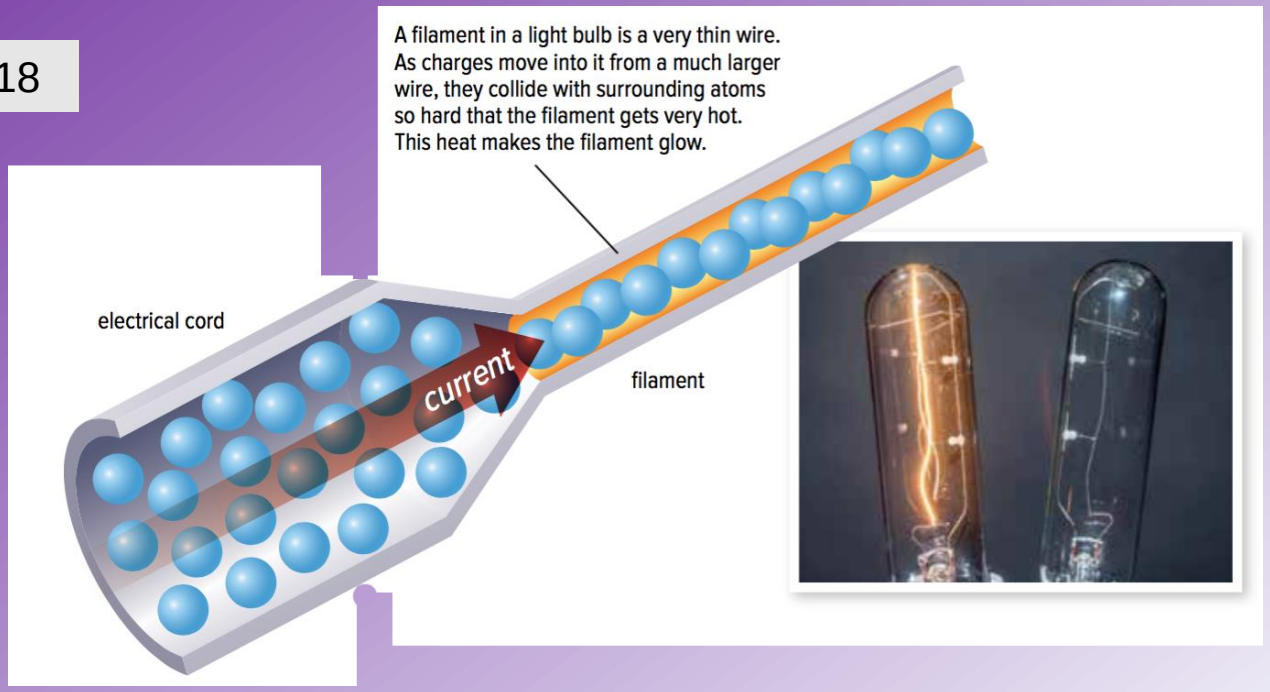


Figure 3.18

Example of Resistance: Filament in a Light Bulb

- Charges move from a large wire (electrical cord) into a very thin wire (filament)
- Since the charges have less room in the filament (the filament *resists* the movement of charges), they collide with atoms so hard that the filament gets very hot
- The heat makes the filament glow ("light up")

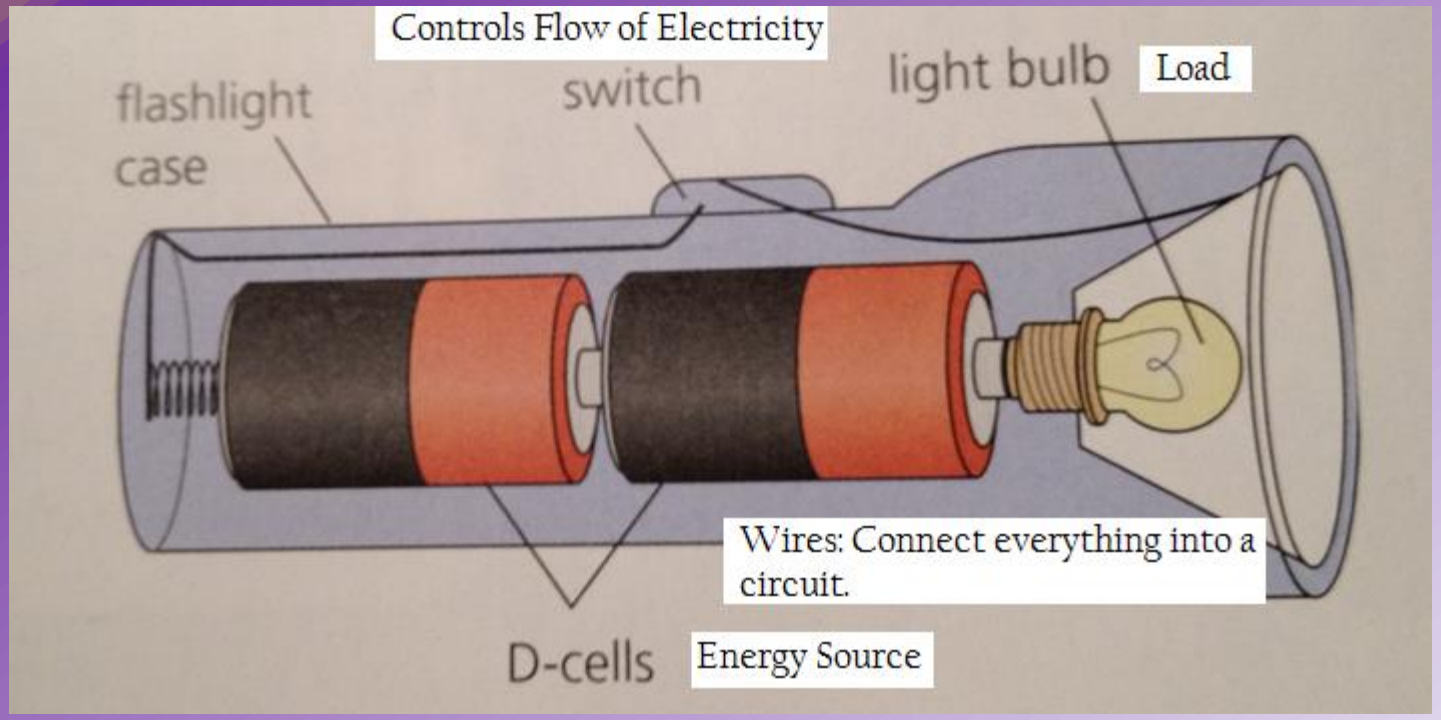
Figure 3.18



Discussion Questions

1. Use the terms source, current, and load to describe how you think a flashlight works.

Example: Flashlight



Conductors must form a closed loop to allow current to flow.

Electrical circuit: A source, a load, and wires in a closed loop that allow current to flow

Example: Figure 3.19

- Source (electrochemical cell)
- Load (lightbulb)
- Wires

Figure 3.19: A closed loop allows current to flow and light the bulb.

Short Circuits

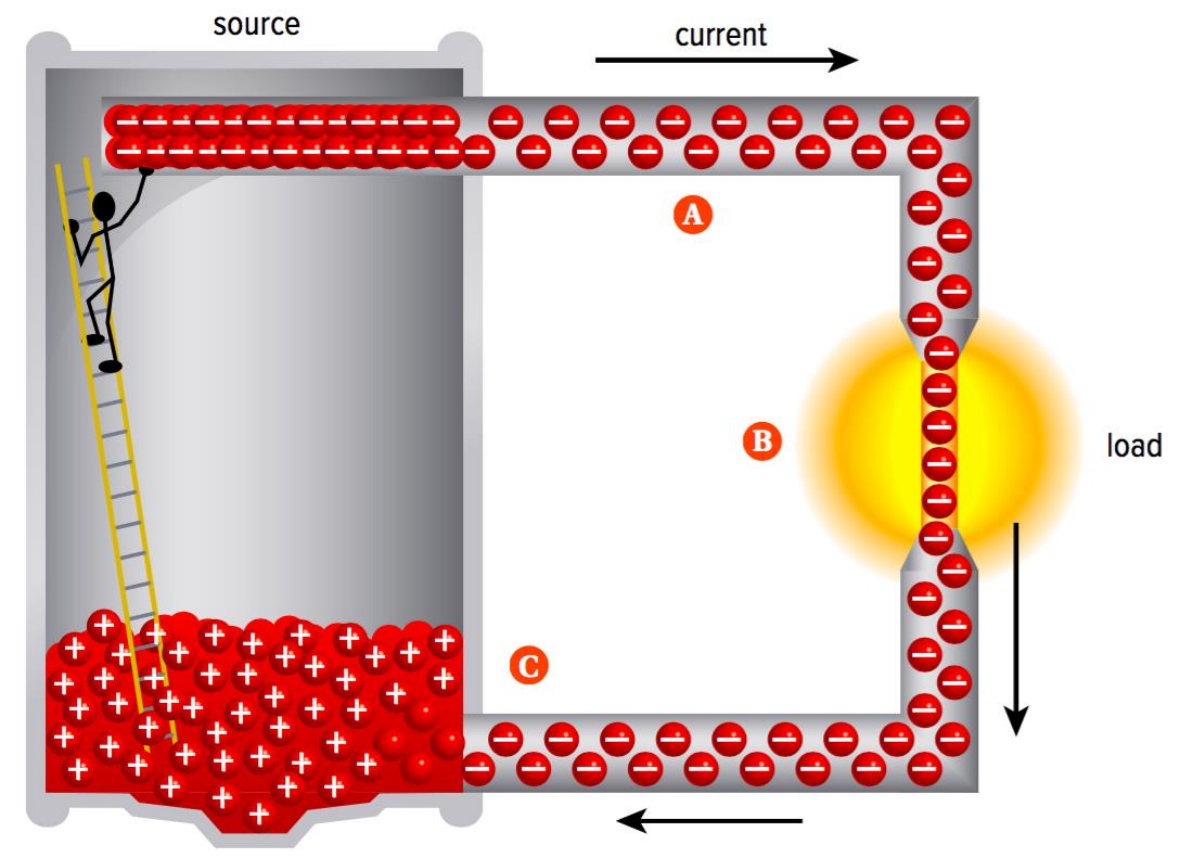
Short circuit: A circuit with a resistance that is too low, making the current so high that it is dangerous

- Example: If there wasn't a load (light bulb) to resist the flow of current, the current would be so large that the conductor would get very hot and start a fire

Figure 3.19: A closed loop allows current to flow and light the bulb.

Modelling the Flow of Current (Part A)

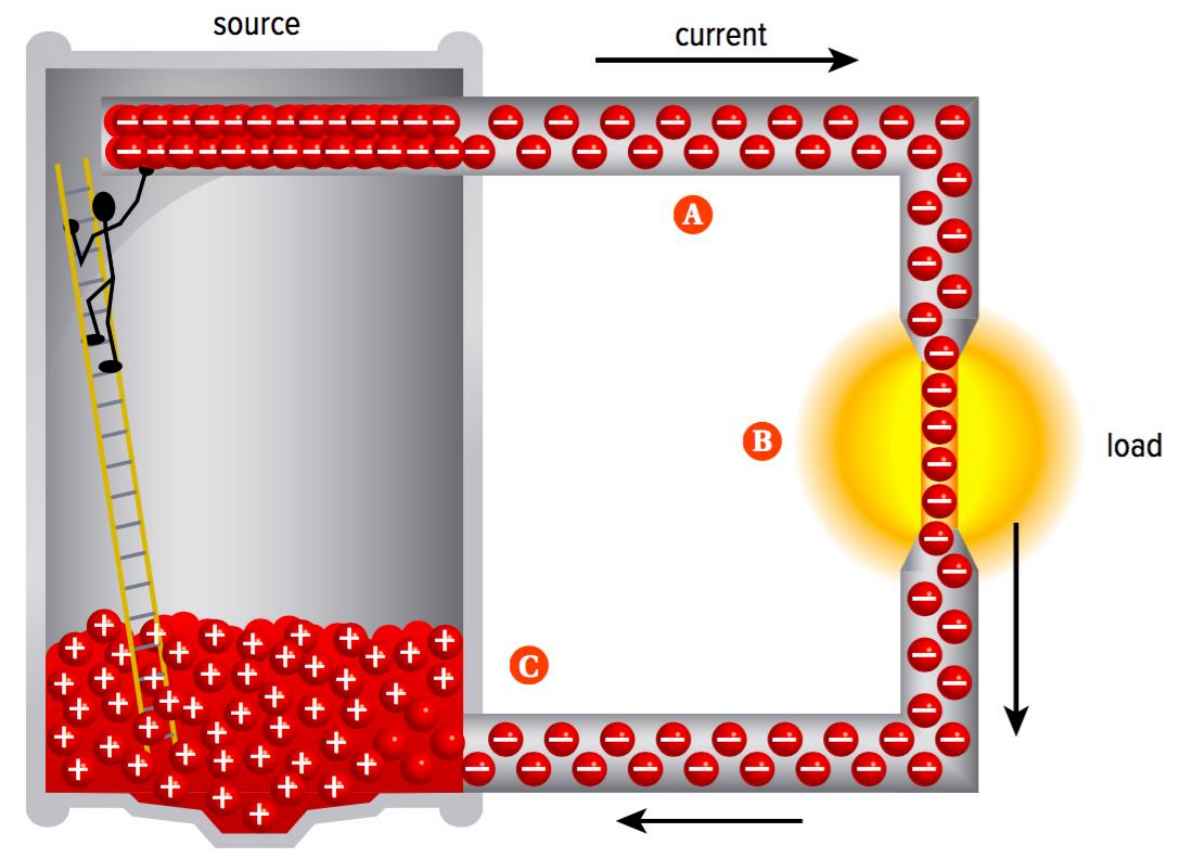
Figure 3.20: How current flows through a circuit



- Negative terminal repels the negative charges already in the conductor
- Positive terminal attracts the negative charges already in the conductor
- Electrons move along the conducting wires; electrons from the electrochemical cell move into the conductor

Modelling the Flow of Current (Part B)

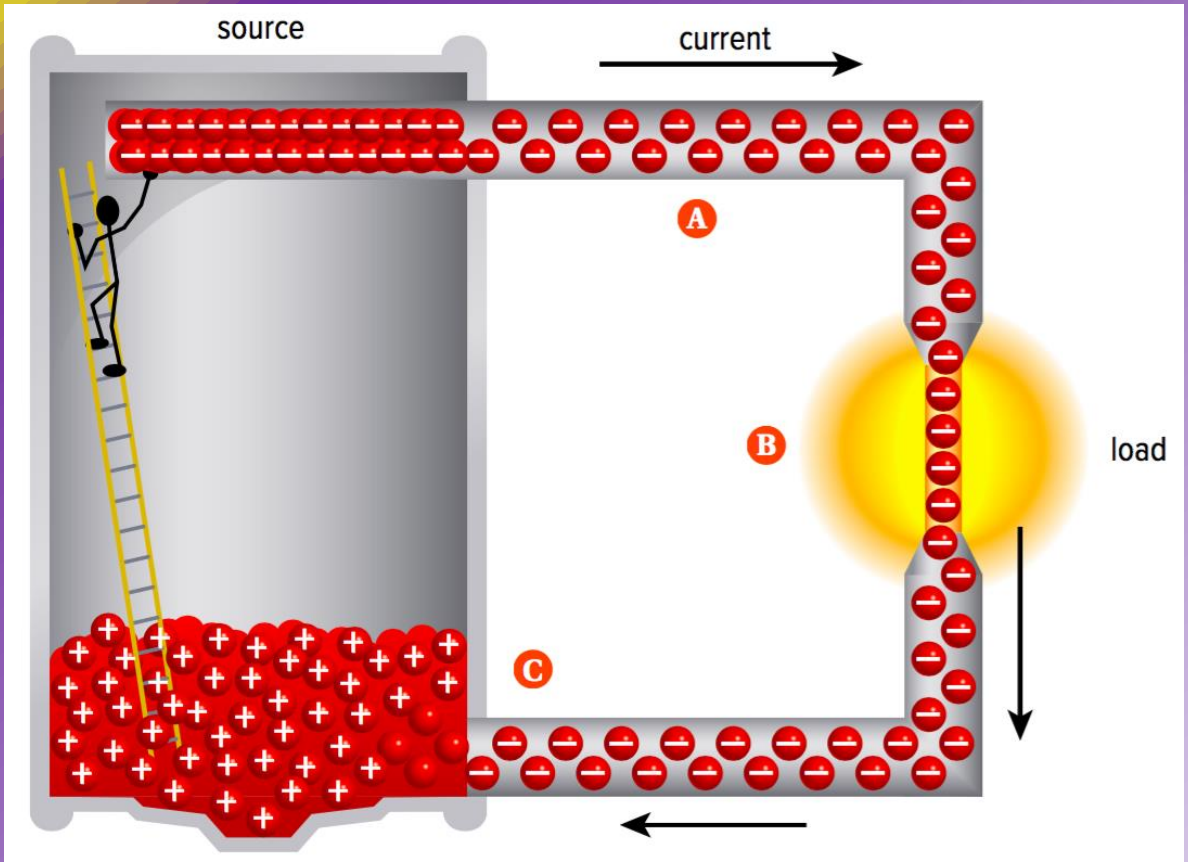
Figure 3.20: How current flows through a circuit



- As the electrons pass through the load, they transfer some of their energy to the load
- The electrons then leave the load and return to the electrochemical cell

Modelling the Flow of Current (Part C)

Figure 3.20: How current flows through a circuit



- Electrons enter the electrochemical cell; combine with positive ions to become neutral
- Over time: fewer electrons at negative terminal; fewer positive ions at positive terminal
- The worker (chemical energy) can carry more electrons up the ladder, keeping the number of separated charges equal

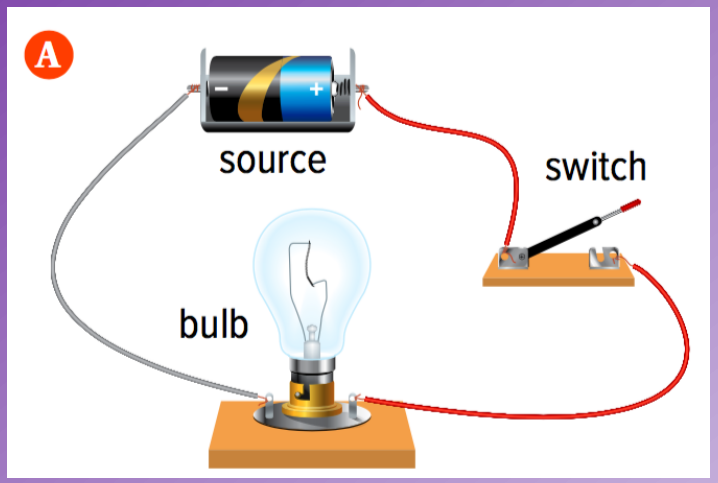
Controlling the Flow of Current

In a typical circuit, a switch controls current in a circuit

Example: Figure 3.21

A. The switch is open. The circuit is open so the current cannot flow.

B. The switch is closed. The circuit is closed so the current can flow and the light is on.



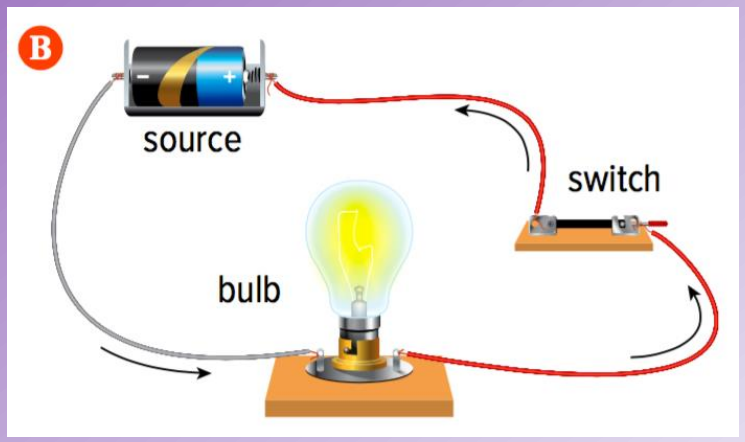
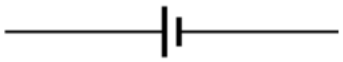


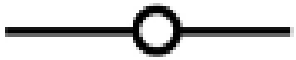
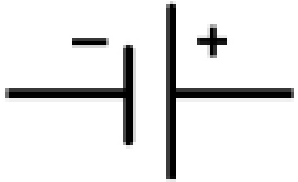
Figure 3.20: How a switch controls current in a circuit

Using Circuit Diagrams

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.

Ammeter	Voltmeter	Light bulb
		
Connection point	Resistor	On/off switch
		
Wire	Dry cell	
		

Lets Try out a circuit

Comparison: Water Circuit and Electrical Circuit

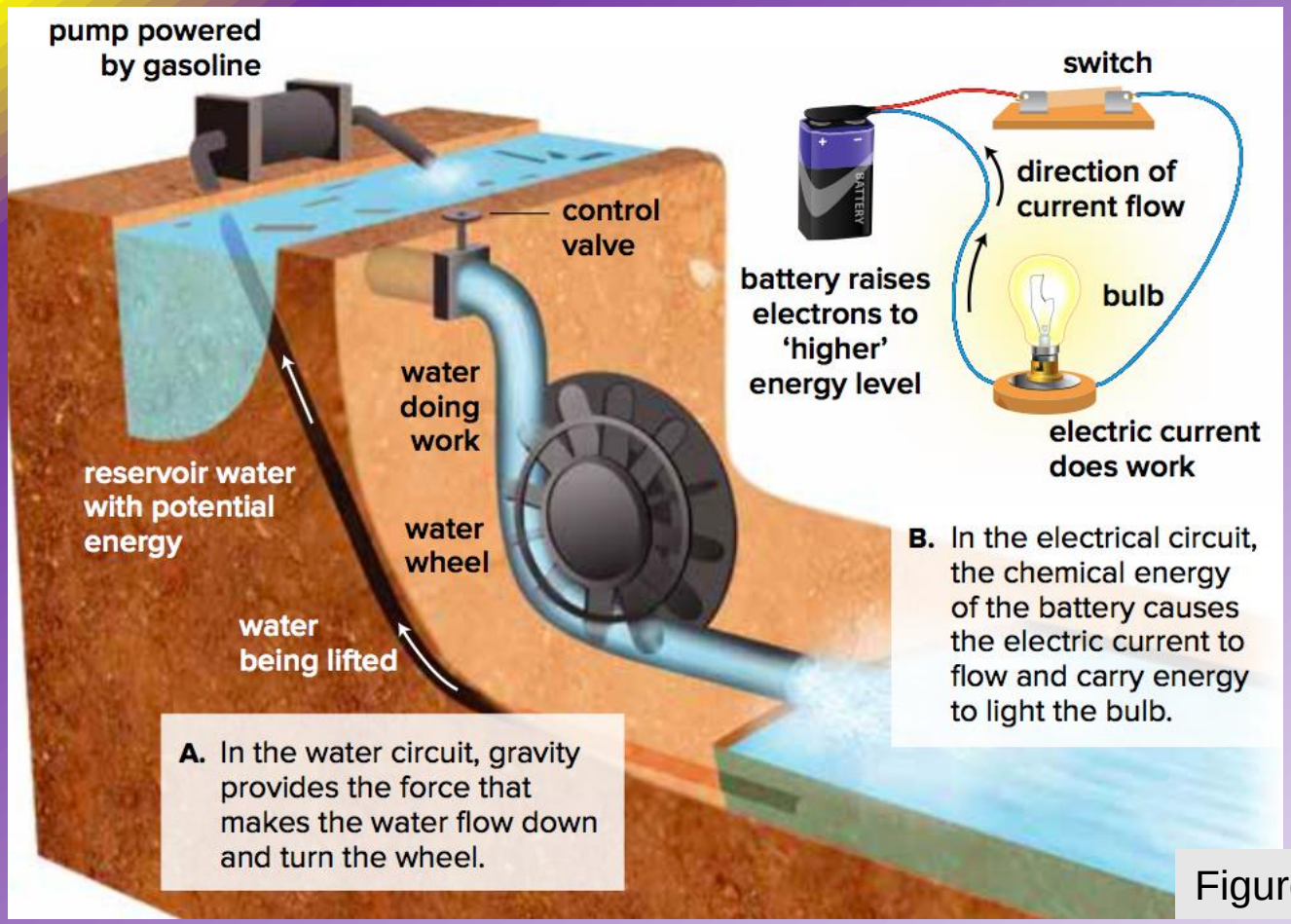


Figure 3.23

- Water circuit: A pump lifts the water to a higher level against the pull of gravity
- Electrical circuit: The cell or battery is similar to the pump

Discussion Questions

1. Explain what “short circuit” means.

2. Describe the role of a switch in an electrical circuit.

3. Draw a circuit diagram for the circuit shown in Figure 3.21B.