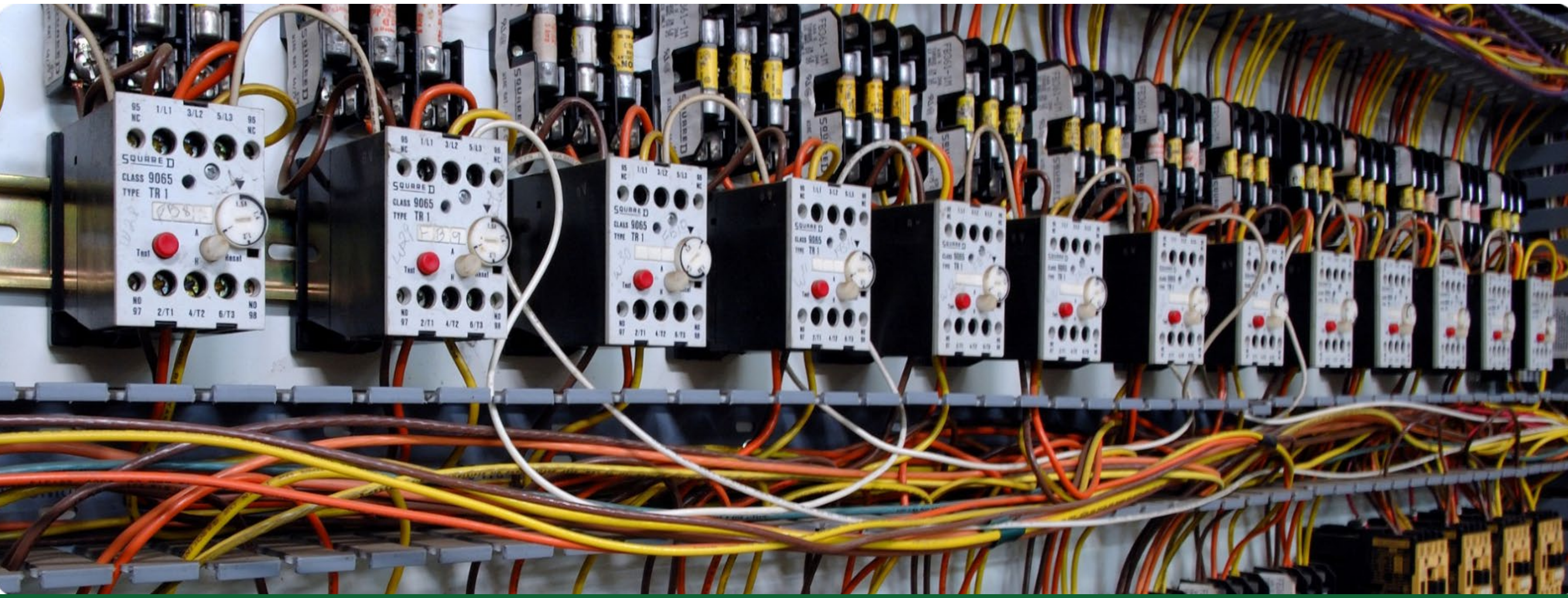
Transit Core Competencies Curriculum

Participant Resource Guide

Electrical Foundations

May 2026



Course Outline

Module 1: Introduction to Electricity

- Module 2: Basic Electrical Principles
- Module 3: AC and DC Electricity
- Module 4: Circuit Components & Architecture
- Module 5: Magnetism and Electromagnetism
- Module 6: Electrical Tools
- Module 7: Safety and PPE

TWC TRANSIT WORKFORCE CENTER

U.S. Department of Transportation
Federal Transit Administration

A program of the Federal Transit Administration administered by the International Transportation Learning Center

Course: Electrical Foundations
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Module 1 – Introduction to Electricity

Objectives

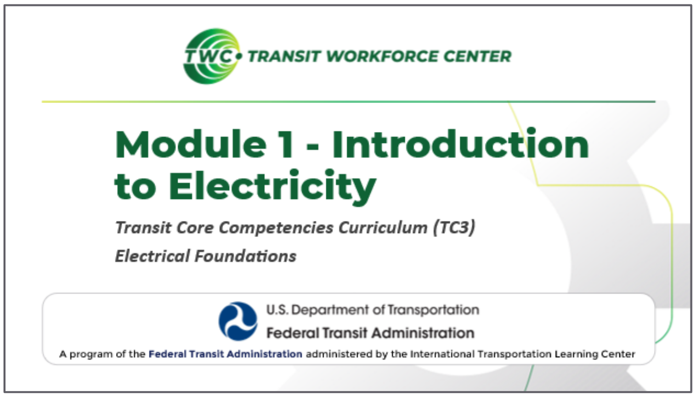
- Explain what electricity is and how it is used in everyday work.
- Explain the difference between static electricity and current electricity.
- Explain how electricity is made and why it is important in transit systems.
- Identify key people who helped develop electricity and how their work affects modern systems.
- Describe the basic parts of an atom and explain how electrons create electrical flow.
- Recognize the difference between Direct Current (DC) and Alternating Current (AC).
- Identify conductors and insulators and explain why both are needed for safety.

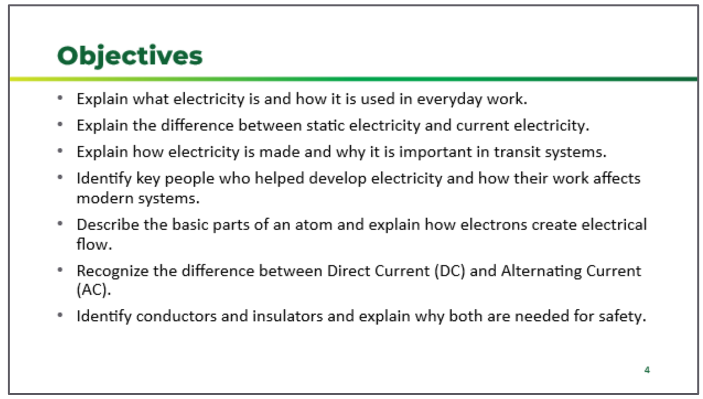
Key Terms

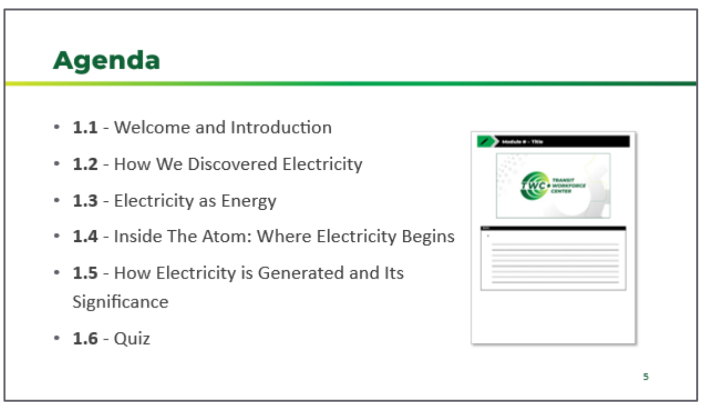
- Alternating Current (AC)
- Amps (Amperes)
- Atoms
- Circuit
- Conductor
- Current
- Current Electricity
- Direct Current (DC)
- Electricity
- Electricity
- Electric Grid
- Electrons
- Insulator
- Neutrons
- Nucleus
- Protons
- Static Electricity
- Voltage

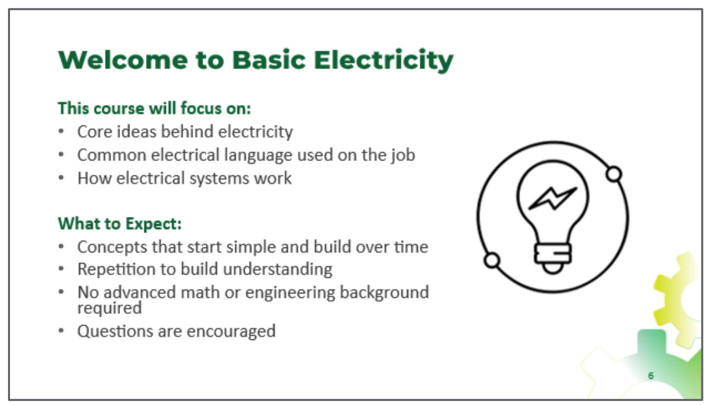
Participant Resource Guide

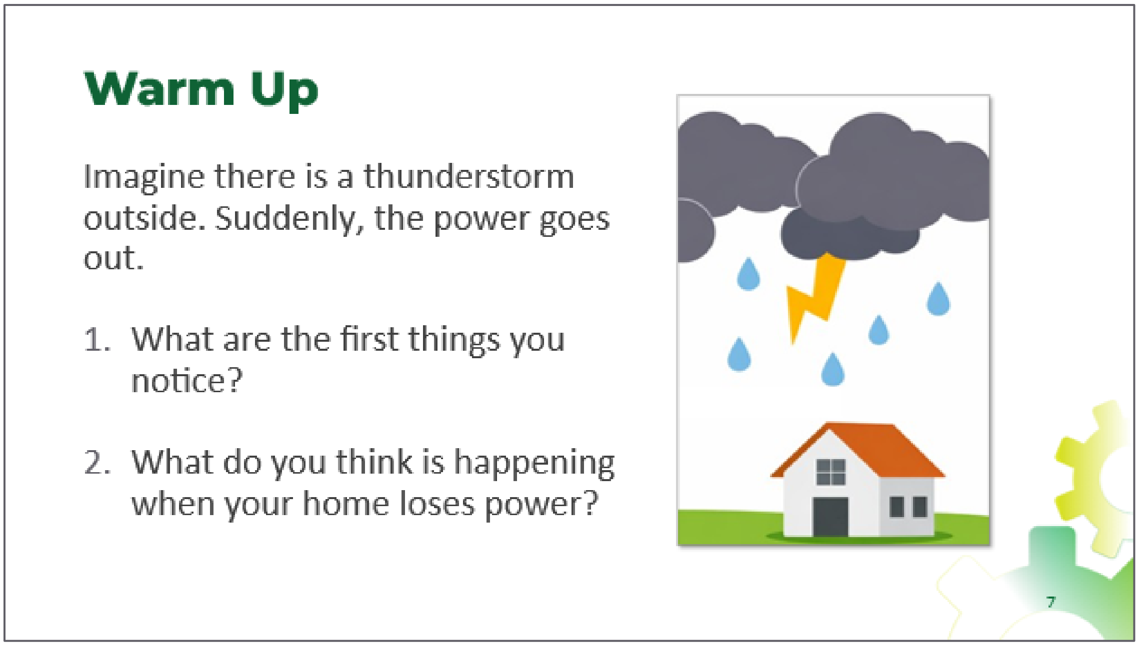
Introduction to Electricity





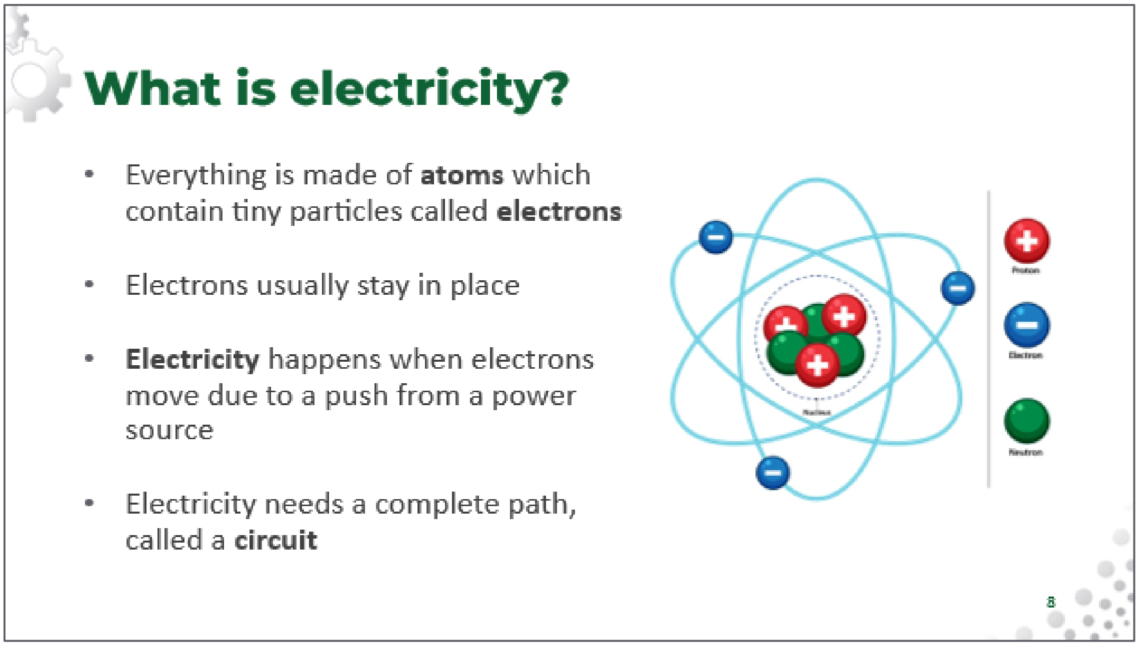






Notes:

- Picture a thunderstorm outside. There's a loud boom, and suddenly the power goes out.
- Take a second and think about the first things you notice. What changes right away when the power is gone?
- When you lose power, nothing inside your house suddenly breaks, but the electricity isn't available anymore.
- What do you think is happening when your home loses power?
- We'll come back to these predictions in a few moments.
- In the next part, we'll look at a very simple circuit to help explain what's happening behind the scenes when power is on — and what changes when it's not.



Notes:

- Understanding what happens when the power goes out in your home starts with the question, "What is electricity?"
  - Everything around us is made of **atoms**.
  - Inside atoms are tiny particles called **electrons**.
- Under normal conditions, those electrons stay where they are.
- **Electricity** is what we call it when electrons start to *move*. That movement doesn't happen on its own — something has to push them.
  - That push usually comes from a power source. It could be a battery, a power supply, or another electrical source.
- One important thing to understand is that **electricity doesn't move randomly**.
- Electrons need a complete path to travel. That complete path is called a **circuit**.
- If the path is broken, the electrons stop moving — and the electricity stops.

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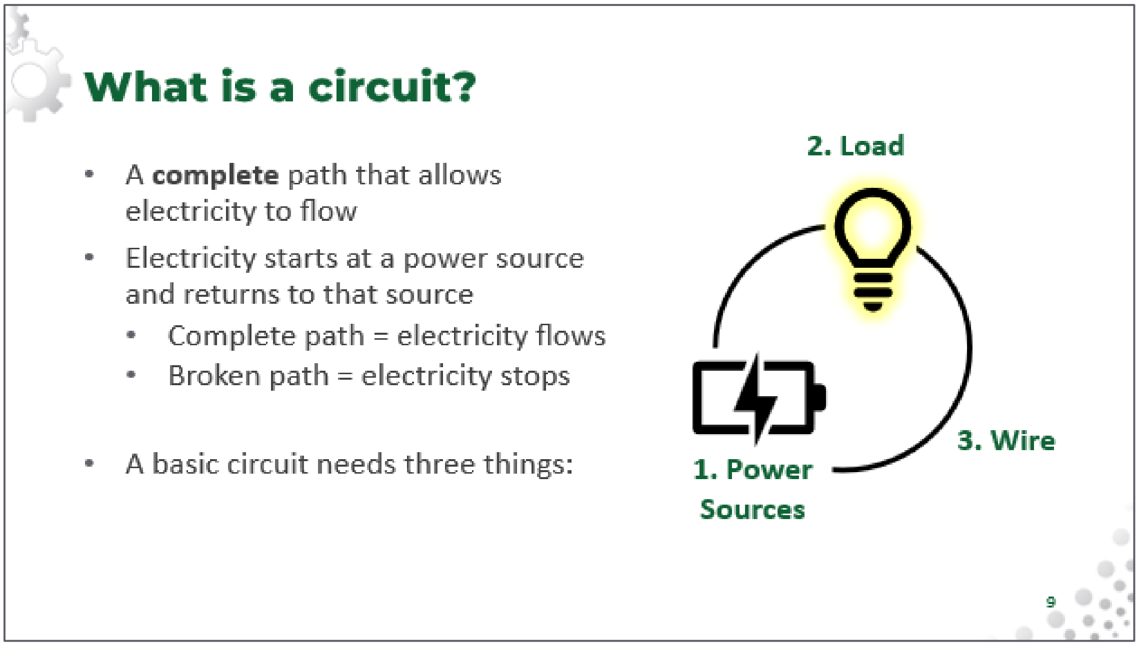
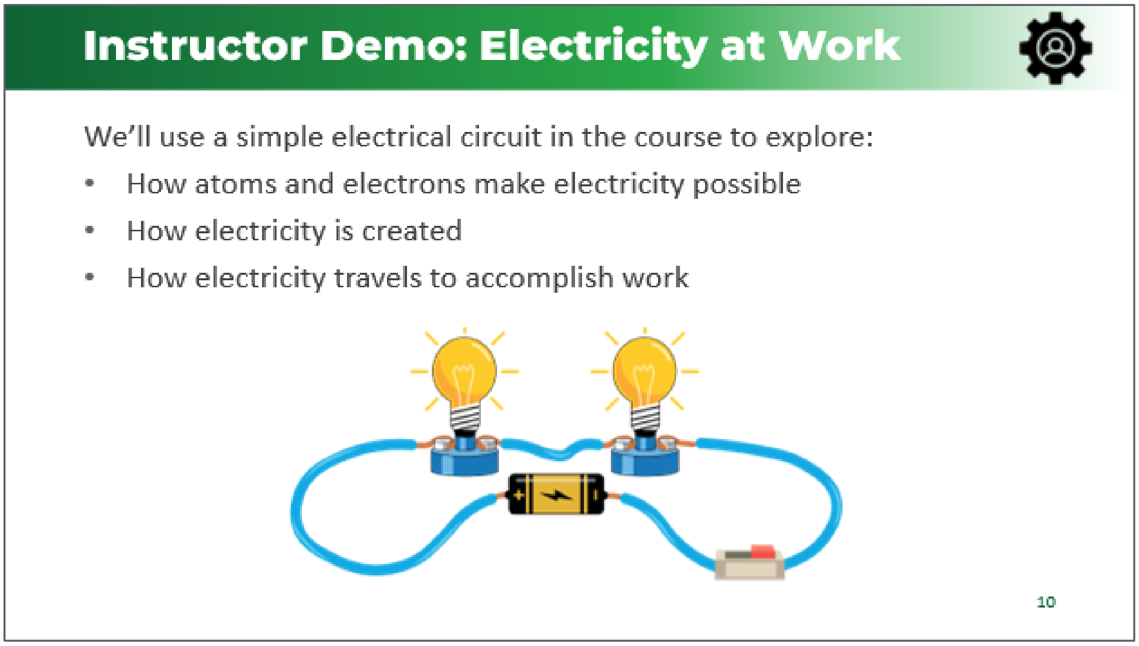


Notes:

- On the last slide, we talked about electricity as the movement of electrons. For those electrons to move, they need somewhere to go. A **circuit** is the path that allows that movement to happen. It's a complete loop that starts at a power source and eventually returns back to it.
- When that path is complete, electrons can move and electricity flows
- If the path is broken anywhere along the way, the movement stops
- Every basic circuit needs three things:
  1. First, a power source — something that provides the push, like a battery or power supply.
  2. Second, a load — something that uses the electricity to do work, like a light or a motor.
  3. Third, a path — usually wires — that gives the electrons somewhere to travel
- All three have to be connected in a loop for the circuit to work. That loop is what keeps the electrons moving
- We'll study circuits in more detail later, but for now, the key idea is simple: <u>electricity only does useful work when it has a complete path to follow.</u>

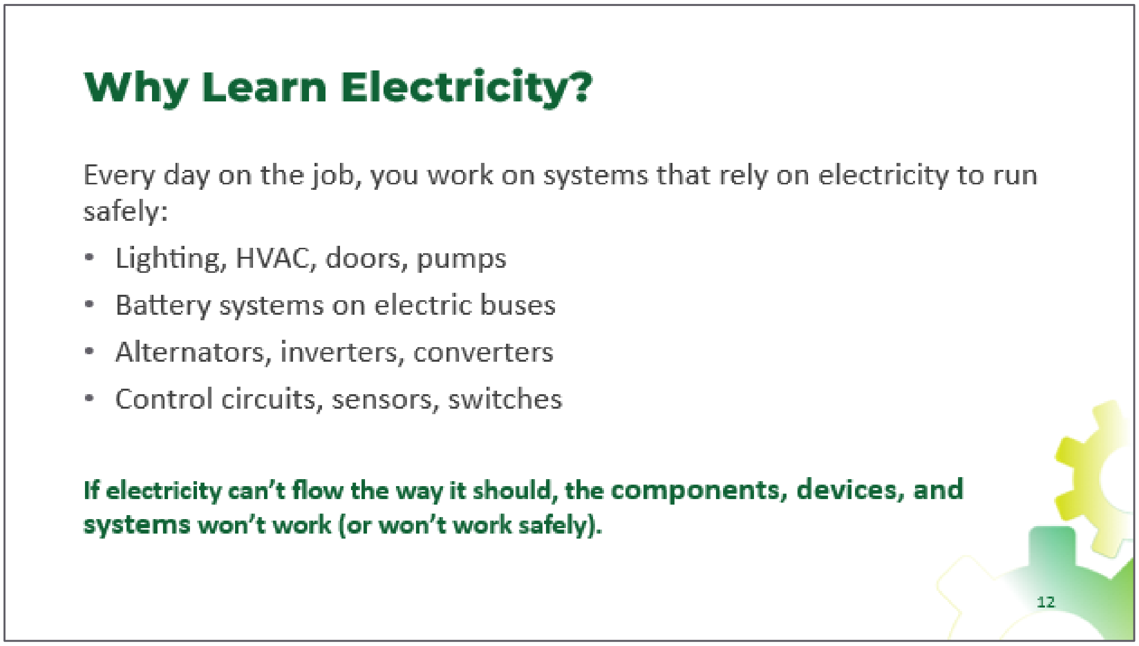


Notes:

- Let's start with a simple circuit. We can build a small circuit — battery, wires, and a bulb — because the exact same principles apply to:
    - Headlights and marker lights
    - Fan motors and blowers
    - Door systems
    - Pumps, sensors, and so much more
- If you understand what's happening in this small circuit, you can apply this understanding to a wide variety of machines.

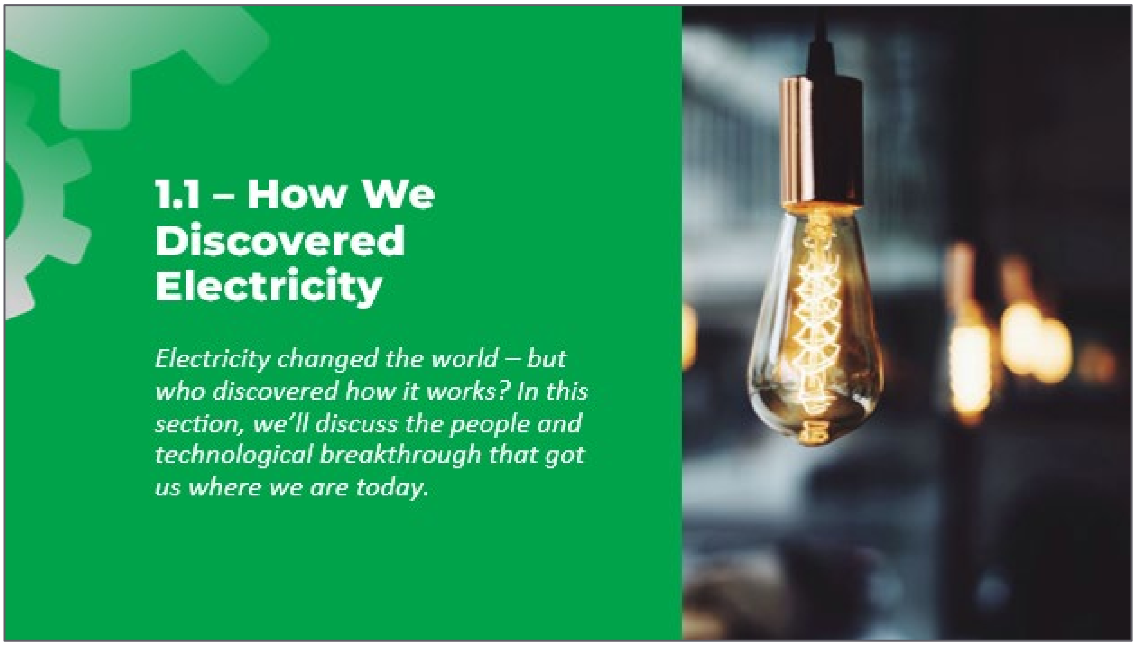
Notes:

- Let's return to our warm-up scenario now that we have a fuller picture of what's going on.
- What are the three things we need for electricity to flow in a circuit?
  - We need a **power sources**, a **wire** to create a path, and a **load**. In this case the load is your home – the thing that needs power.
- Same question as before - What happens when your home loses power?
  - Usually when our home loses power, the path (wire) has been disrupted causing the electricity to stop flowing. The result? Our home loses power.
- Look back at the predictions on the white board/flip chart. Did we predict anything correctly? Did we make any errors?



Notes:

- Before dive deeper into today's topic, it's important to talk about why electricity matters.
- This isn't just theory — it shows up in the systems you work with every day.
- Things like lighting, HVAC, doors, pumps and battery systems are critical to keeping vehicles moving.
- You'll also run into components like alternators, inverters, and converters. And behind the scenes, control circuits, sensors, and switches are constantly at work.
- When electricity flows the way, it's supposed to, these systems do their job. When it doesn't, systems may not work at all — or they may work in unsafe ways.
- The goal of this course is to help you understand what normal looks like. So, when something isn't right, you can recognize it and respond appropriately.



Notes:

- Electricity changed the world – but who discovered how it works?
- In this section, we'll discuss the people and technological breakthrough that got us where we are today.

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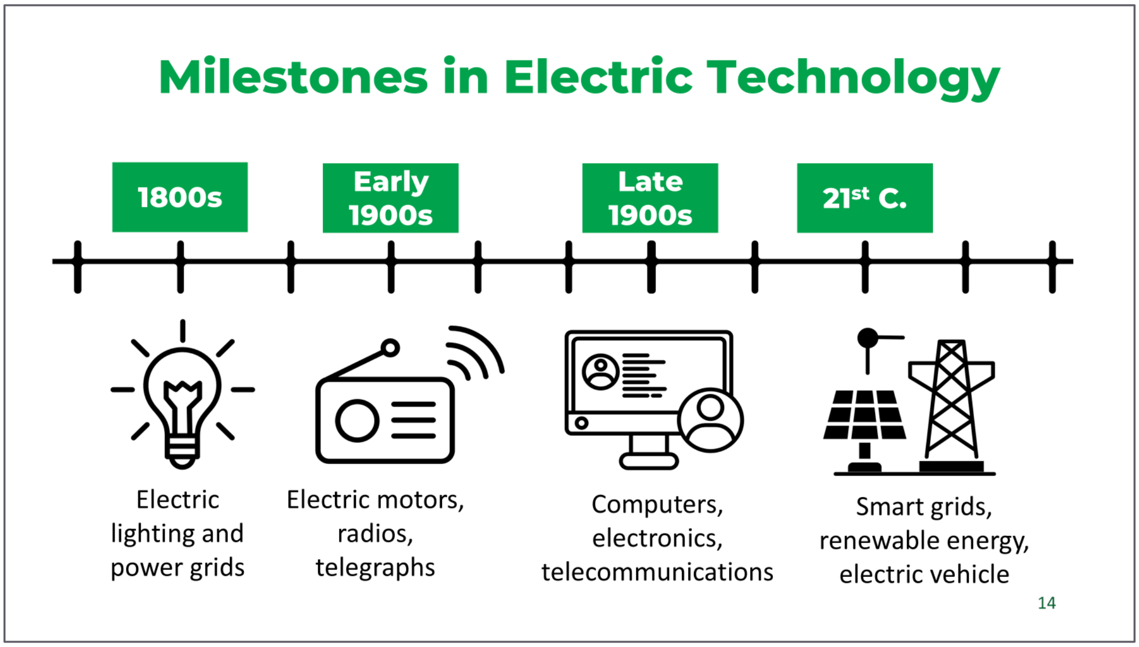

Notes:

- Electricity wasn't invented—it was discovered, studied, and developed over time by some of the greatest scientific minds.
- In the **1880s**, we saw the first electric lights and the development of power grids to deliver electricity to homes and businesses.
- By the **early 1900s**, electric motors, radios, and the telegraph changed communication and manufacturing.
- Most don't know this, but electric cars were invented back in the 1890s! An electric vehicle held the vehicular land speed record until around 1900. The hybrid car was invented in 1903!
- The **late 1900s** brought computers, microelectronics, and global telecommunications—revolutionizing work, education, and connection.
- And today, in the **21st century**, we're seeing smart grids, rapid growth in renewable energy, and widespread use of electric vehicles.
- These milestones show how understanding and using electricity has continually shaped society—and will keep doing so into the future.

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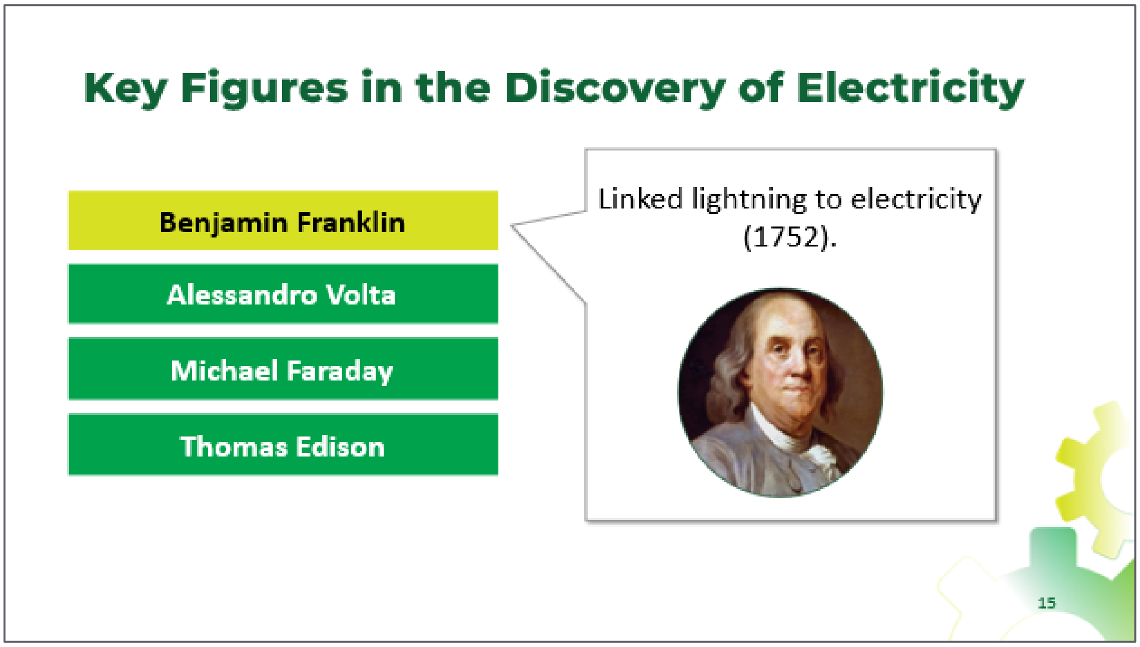

Notes:

- **Benjamin Franklin** demonstrated the connection between lightning and electricity through his famous kite experiment.
- Kite Experiment:
  - Ben Franklin waited until a thunderstorm was happening, and went outside with a kite, string and a key.
  - He wrapped the key in string, which was connected to the kite via the string, which got wet in the rain
  - As the kite flew up into the sky, Franklin noticed the metal key was attracting the lightning coming from the storm clouds
  - Based on his observations, he deducted that lightning was another form of static electrical discharge.

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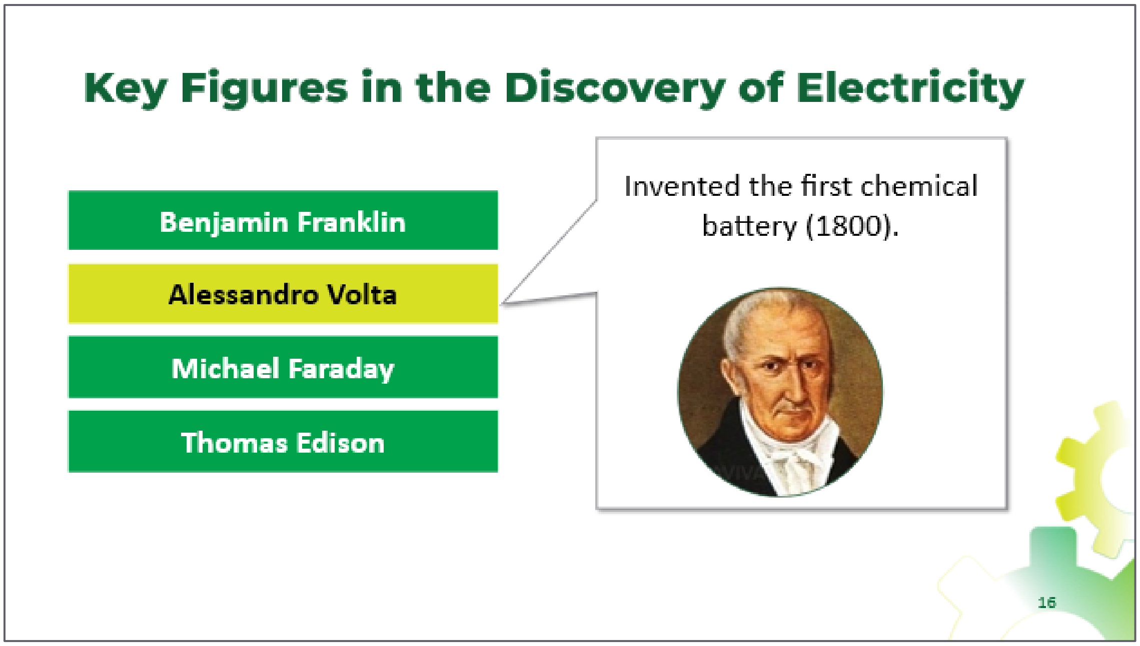

Notes:

- **Alessandro Volta,** a physicist and chemist, created the first chemical battery demonstrating a reliable source of electric current.
- The unit of electrical potential – the volt – was named after him.
- His work helped make the study of electricity practical and measurable. Specifically, his battery allowed studies of electricity to be more easily controlled.

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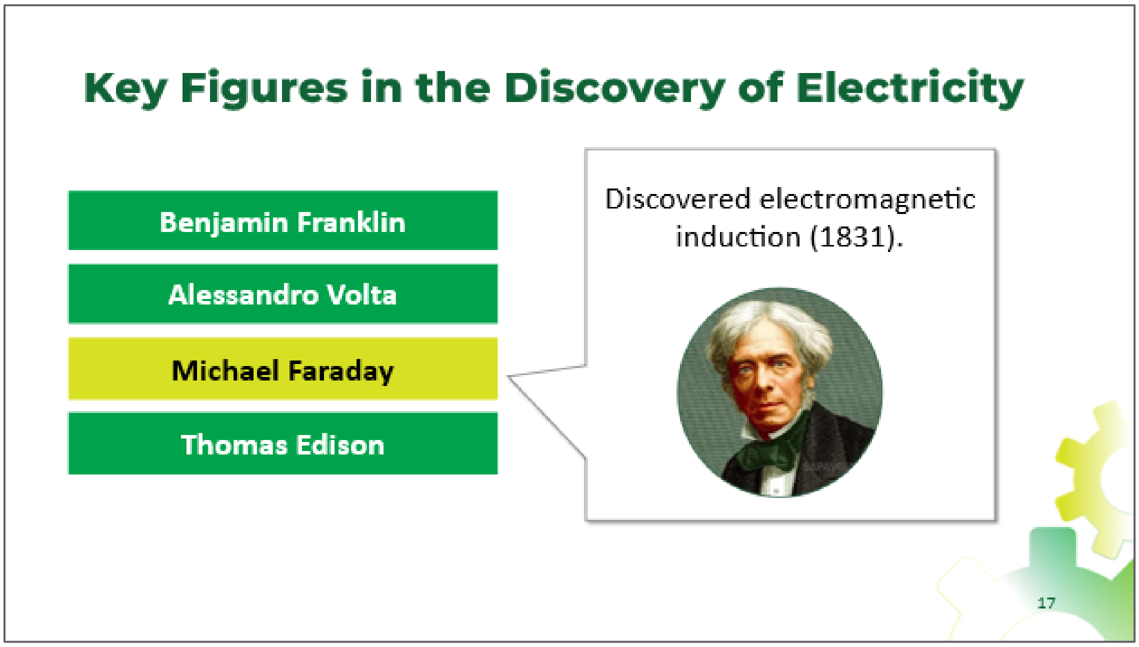

Notes:

- **Michael Faraday** discovered electromagnetic induction, the principle behind electric generators.
- This also helped form the principles behind transformers.
- The principles he discovered help make electricity tangible and offered practical application.

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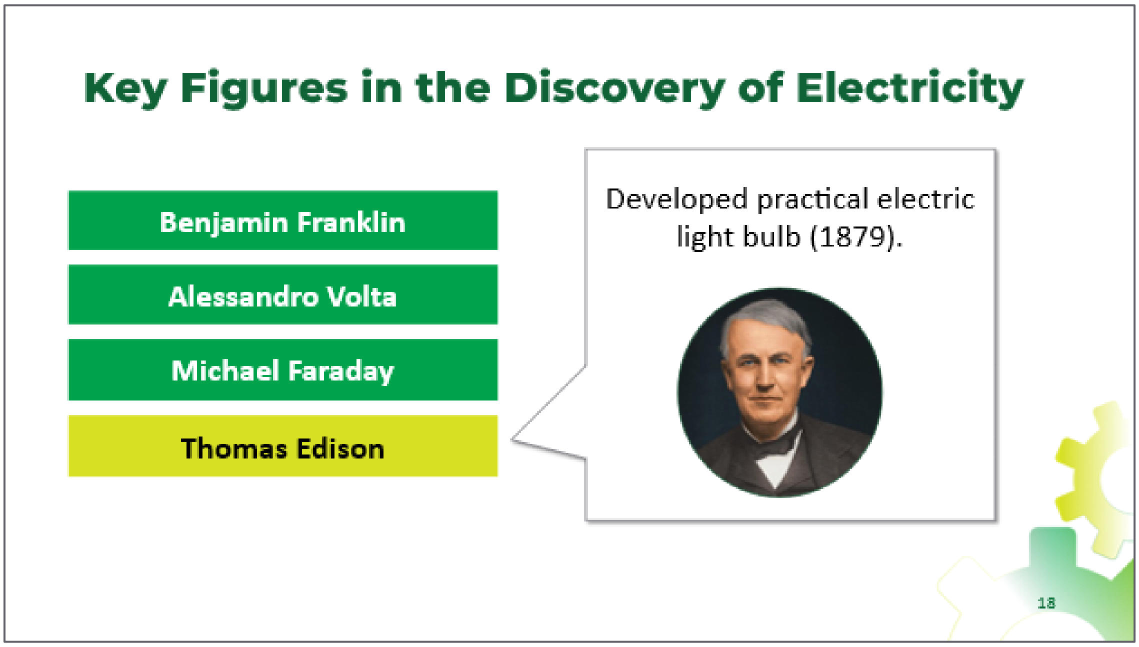

Notes:

- **Thomas Edison** played a key role in electricity by inventing the practical incandescent light bulb and establishing power distribution system.
- He held over 1000 patents on his inventions during his lifetime.
- Under electrical power distribution, Edison helped create the first electrical power system that could deliver electricity commercially to homes and businesses.
- He also played a part in developing the first motion picture camera and projector, while also improving existing inventions such as the telegraph, phonograph and telephone.

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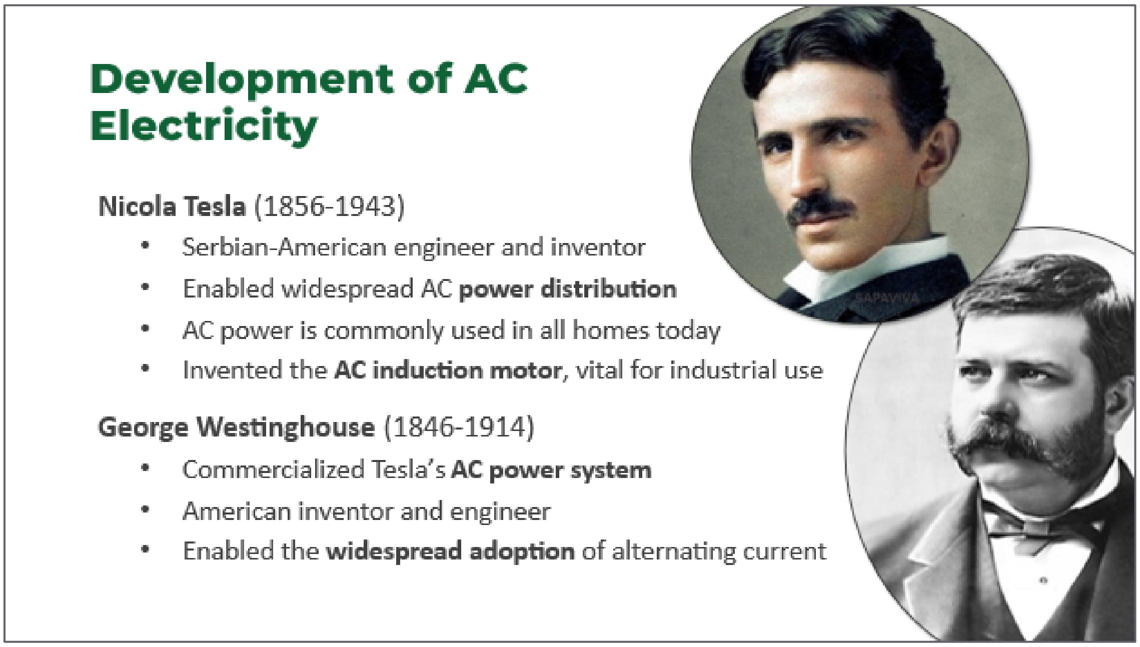

Notes:

- To understand AC electricity, it helps to look briefly at how it developed and who was involved.
- One of the key figures here is **Nikola Tesla**, a Serbian-American engineer and inventor working in the late 1800s.
  - Tesla developed ideas that made alternating current practical for sending power over long distances, which was a big limitation with earlier systems.
  - He also invented the AC induction motor, which is still the basis for many motors used in industry today—including equipment we rely on across transit systems.
  - Because of this work, AC power became the standard for distributing electricity, and it's what we still use in homes and facilities today.
- **George Westinghouse** played a different but equally important role.
  - He was an American inventor and engineer who took Tesla's ideas and figured out how to make them work at a large, commercial scale.
  - Westinghouse invested in and built the infrastructure needed to roll out AC power systems widely.
- Together, Tesla's innovation and Westinghouse's ability to commercialize it led to the widespread adoption of alternating current.
- The big takeaway here is that AC power didn't just appear overnight—it came from a combination of invention and real-world implementation, which is why it became the backbone of modern electrical systems we depend on today.

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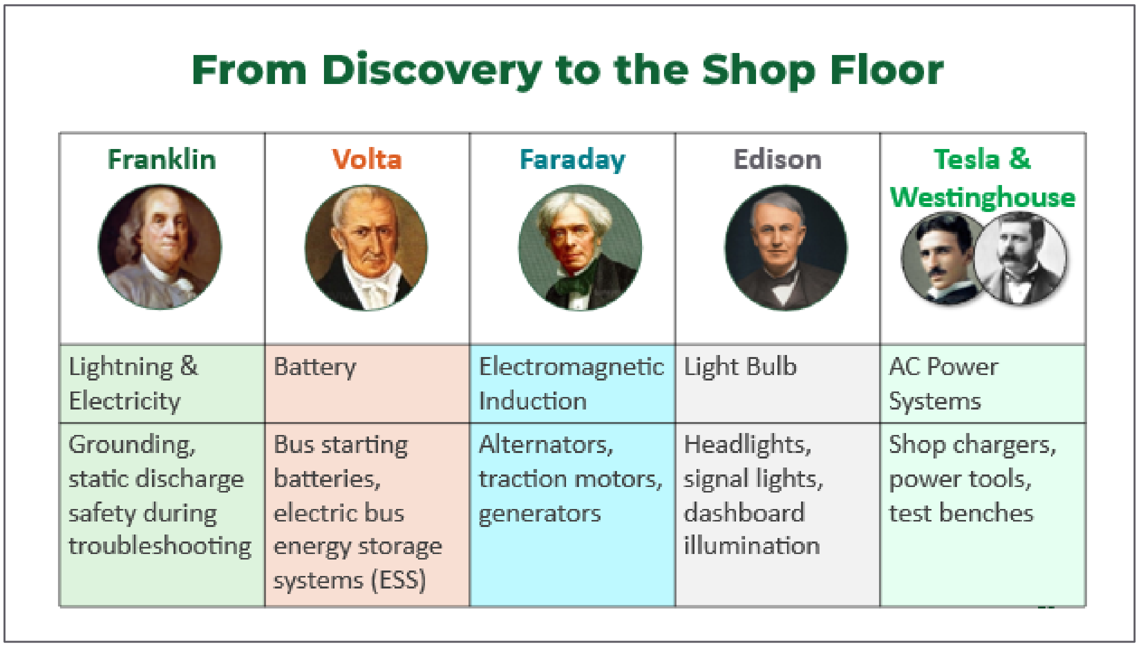

From Discovery to the Shop Floor

Franklin	Volta	Faraday	Edison	Tesla & Westinghouse
Lightning & Electricity	Battery	Electromagnetic Induction	Light Bulb	AC Power Systems
Grounding, static discharge safety during troubleshooting	Bus starting batteries, electric bus energy storage systems (ESS)	Alternators, traction motors, generators	Headlights, signal lights, dashboard illumination	Shop chargers, power tools, test benches

Notes:

- If you look around your shop, you can actually *see* history in action.
  a) Franklin helped identify static electricity (discharge) and how to ground electricity so we can troubleshoot.
  b) The battery you test traces back to Volta.
  c) The alternator you rebuild is Faraday's idea in motion.
  d) The circuits you troubleshoot owe their roots to Edison and Tesla.
  e) Shop chargers, power tools, test benches rely on the AC Power Systems developed by Tesla and Westinghouse.
- Understanding where these ideas come from helps you recognize how systems behave—and why safety and precision matter so much in maintenance.
- These discoveries are built into every vehicle and every shop tool you use.

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Knowledge Check

Who Invented the first chemical battery?

A. Nikola Tesla

B. Alessandro Volta

C. Thomas Edison

D. Benjamin Franklin

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Knowledge Check

Which of the following scientists played a key role in electricity by inventing the practical light bulb?

A. Alessandro Volta

B. Michael Faraday

C. Thomas Edison

D. Nikola Tesla

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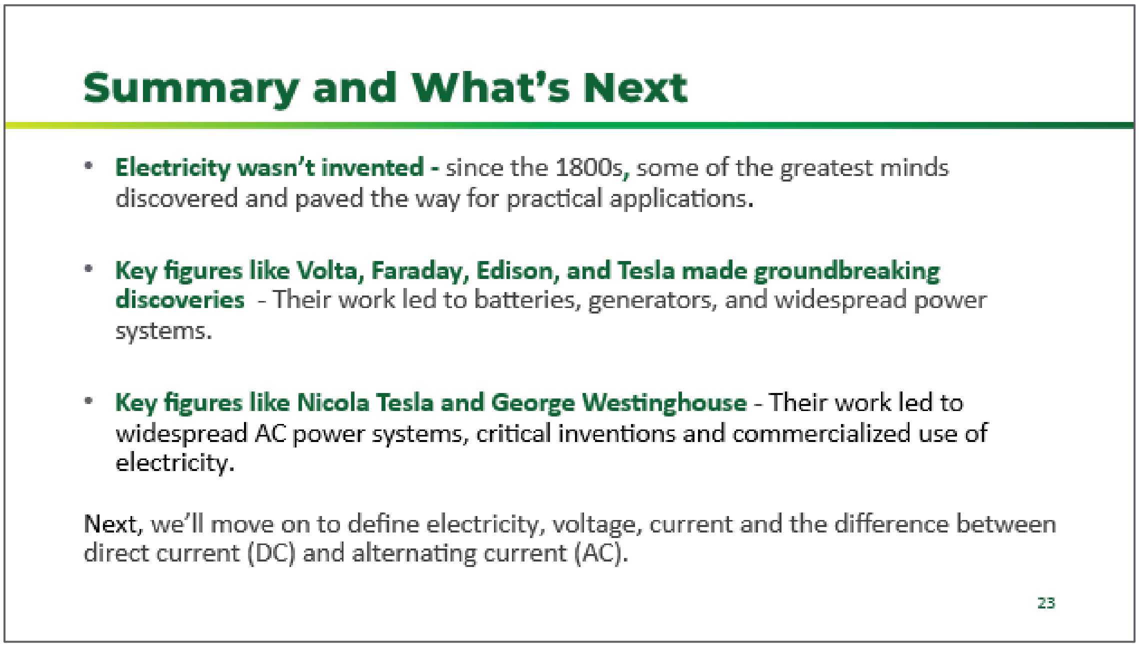

Notes:

- These three areas build a complete picture—from what electricity is, to how it's made, who developed it, and how it works on a microscopic level. By connecting history, science, and real-world use, we've built a foundation for both understanding and applying electrical concepts.
- Let's review the key concepts from this module:
    - **Electricity wasn't invented –** since the 1800s**,** some of the greatest minds discovered and paved the way for practical applications.
    - **Key figures like Volta, Faraday, Edison, and Tesla made groundbreaking discoveries**. Their work led to batteries, generators, and widespread power systems.
    - **Key figures like Nicola Tesla and George Westinghouse -** Their work led to widespread AC power systems, critical inventions and commercialized use of electricity.
    - **What's Next?** We'll move from who discovered electricity to what it actually *is* — the form of energy that powers every system you maintain.

Notes:

- Electricity is a type of energy that makes our systems work.
- In this section we'll explore what it is and how it powers the equipment we maintain.

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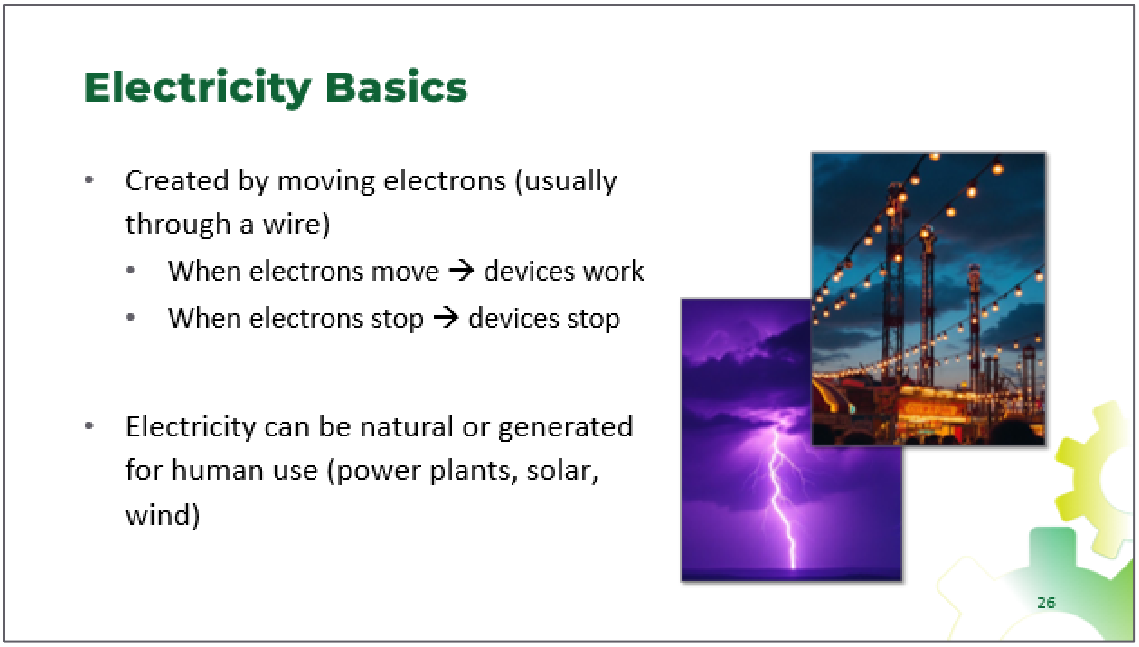
Notes:

- Electrical work always starts with safety — **no exceptions**.
- Electricity is powerful, and even low-voltage systems can be dangerous.
- Shocks, burns, and fires can happen if safety rules aren't followed.
- A big part of staying safe is understanding what you're working with. You should never work with electricity unless you're confident you know what's going on. That's why there are a few best practices we always follow.
    - We wear proper protective equipment and use tools designed for electrical work.
    - We make sure circuits are de-energized before working on them and we follow lockout/tagout procedures.
- That means locking out the power source and tagging the equipment, so no one accidentally restores power.
- Awareness and preparation are key to working safely around electricity.
- You'll get into electrical safety later in the course. For now, the takeaway is simple: understanding electricity helps keep you safe.



Notes:

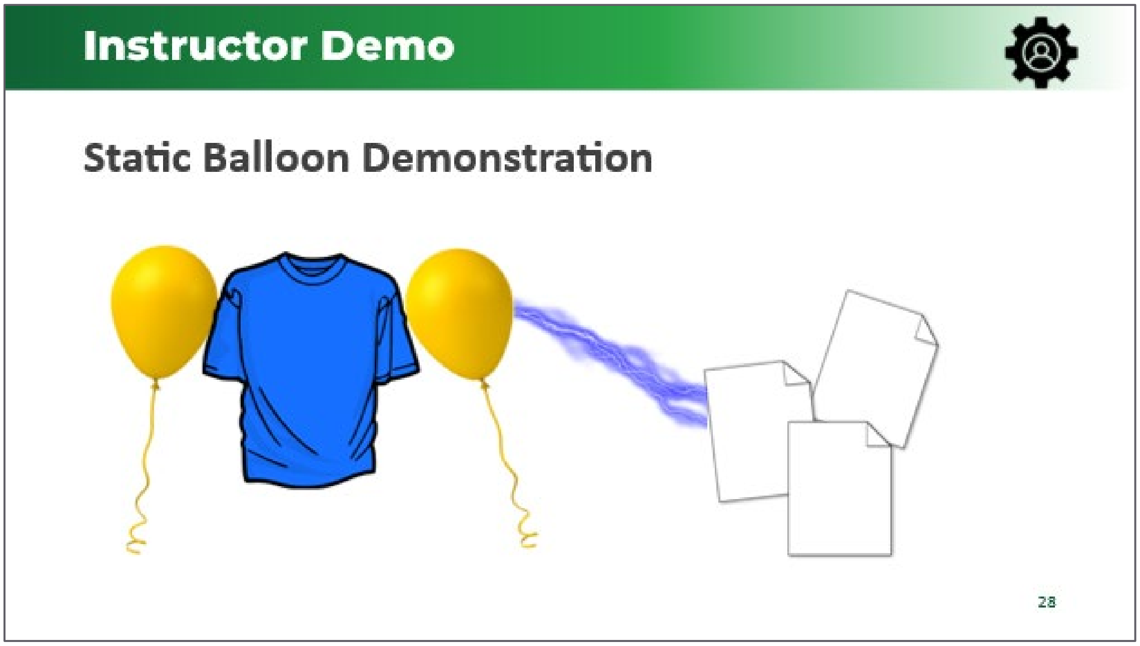
- Electricity isn't a substance you can hold. It's the flow of energy, caused by electrons moving through a material, usually a wire.
- When electrons are moving, things work. Lights turn on, motors run, blowers spin, relays click, and batteries charge.
- When that movement stops, the system stops working. Nothing else has to break — the electrons just aren't moving anymore.
- Electricity can occur naturally, like lightning during a storm, but we've also learned how to generate it and control it.
- That control is what allows us to power homes, vehicles, tools, and technology.
- It's also what makes electricity so powerful — we can move energy over long distances.
- By moving electrons through a wire, we can light cities, operate machinery, and run modern systems.
- That's why electricity is essential to technology, communication, transportation, and even medicine

Static Electricity

- Static electricity is **built-up charge** sitting on a surface until it suddenly releases.
- Electrical energy that is **stored**.
- **Like a battery**, your body can store static charge and release it suddenly.

Notes:

- There are two main types of electricity you should know about: **static electricity** and **current electricity**.
- **Static electricity** is when electric charge builds up on the surface of an object.
  - It stays in place until it's suddenly released—like a shock from a doorknob, or a lightning bolt during a storm.
  - You've also felt it when rubbing socks on a carpet and then touching metal.
  - Static electricity is like water stored in a tank. Stored energy builds up due to friction or separation of charges.



Notes:

- What happened when we rubbed the balloons on a shirt?
- What do you think happened after putting a hand near the paper?
- Where have you seen static electricity on the job?
- That stored charge built potential energy — that's like *voltage*.
- Voltage can exist even without a visible current.

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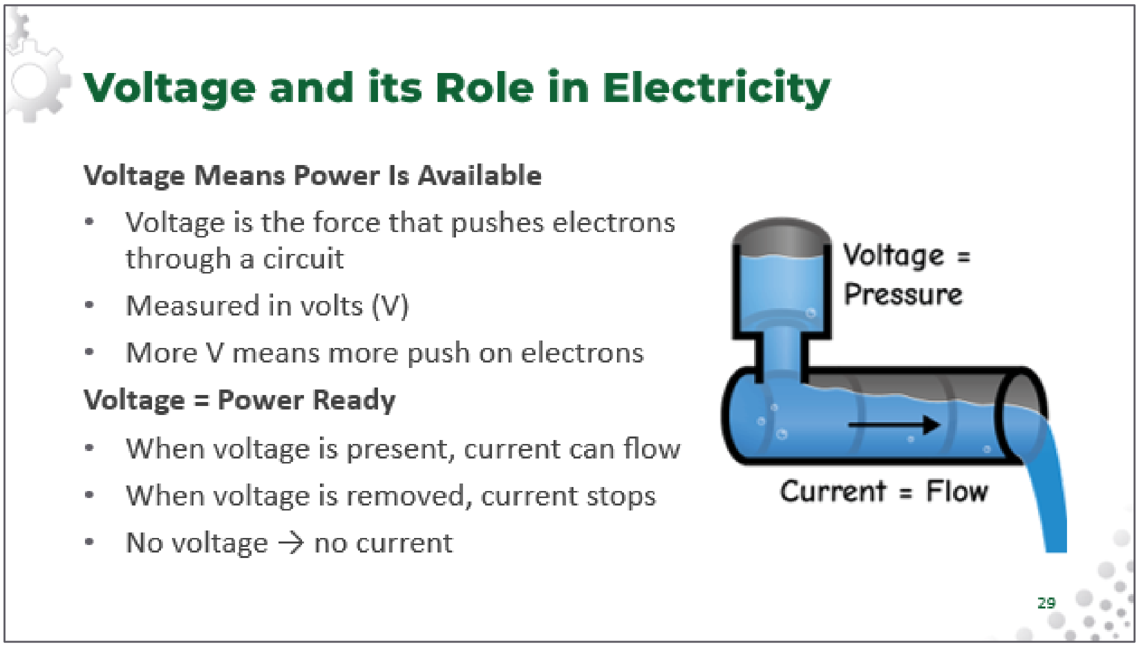

Notes:

- Voltage does not mean the light is on. It means the light *can* turn on.
    - Voltage Means *Power Is Available*
- **Voltage** is the force that pushes electrons through a circuit. We measure that force in volts.
    - More voltage means more push on the electrons
- Electrical equipment, like a light bulb, needs voltage (a force) to make current flow, but the voltage might not always be active (flowing).
    - Voltage = Power Ready
- When voltage is present and the circuit is complete, electrons move and the light turns on.
- When voltage is removed or disconnected, electrons stop moving and the light turns off.
- A good way to think about voltage is water pressure.
- The pressure can be there in the pipe, ready to flow, even if the faucet is closed.
- That's why a battery can show voltage but still not power a load.

Everyday Maintenance Examples

Scenario	Does it have voltage?	What's Happening
A bus door when power is off		
Door motor when door "on" switch is pressed		
A battery sitting on a work bench		
A break in the wire		

Notes:

- The following table shows several maintenance examples that you might see everyday in your work.
- **A bus door when power is off.**
  - Does it have voltage? No voltage
  - What's happening? The control circuit isn't energized. Electrons aren't being pushed.
- **The same door motor when door switch is pressed.**
  - Does it have voltage? Yes
  - What's happening? Voltage is applied → electrons flow → motor turns.
- **A battery sitting on a work bench.**
  - Does it have voltage? Yes, potentially
  - What's happening? The battery itself has voltage potential (ex.12V), but no current flows until connected to a circuit.
- **A break in the wire.**
  - Does it have voltage? Voltage may exist before the break, not after.
  - What's happening? Voltage doesn't disappear. It just can't reach the load because the path is open.

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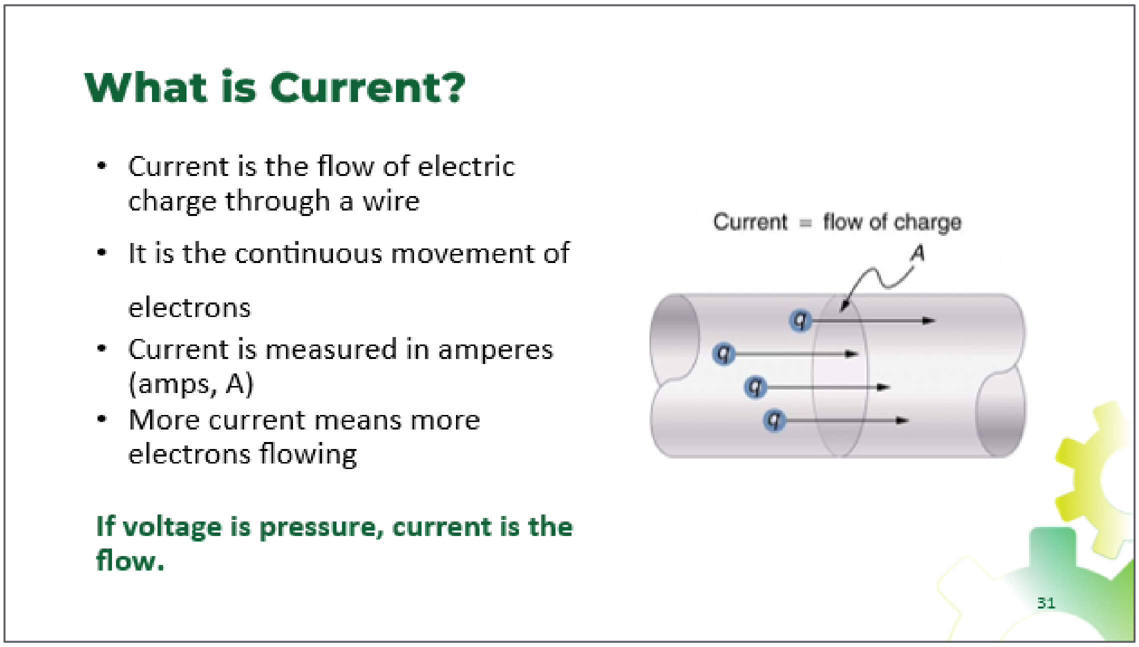
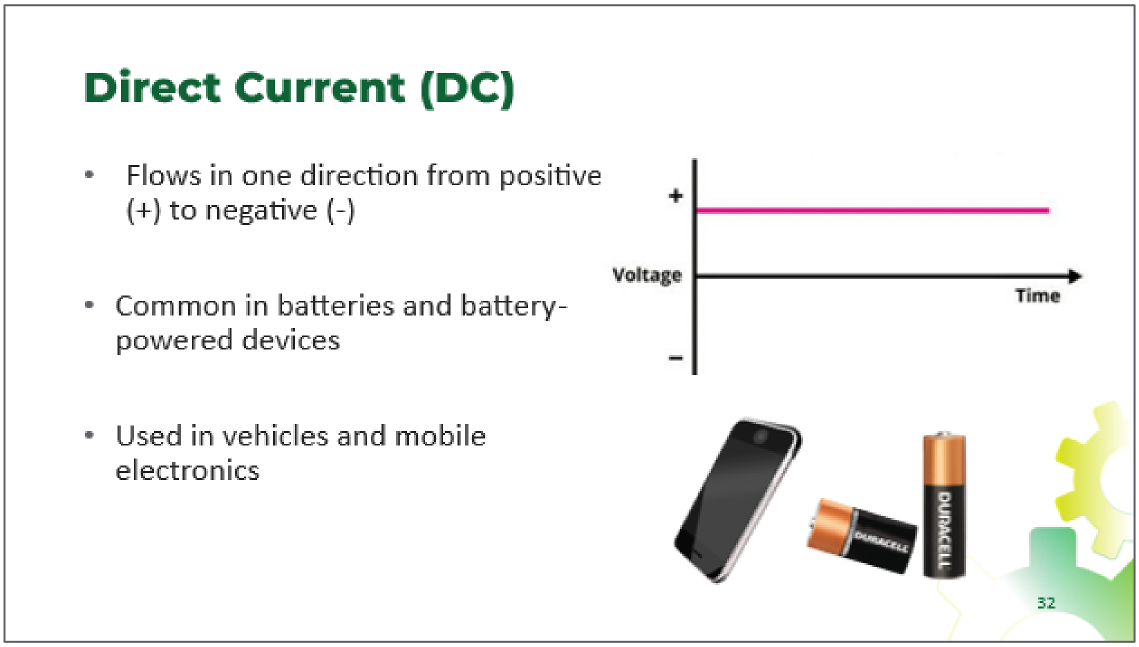


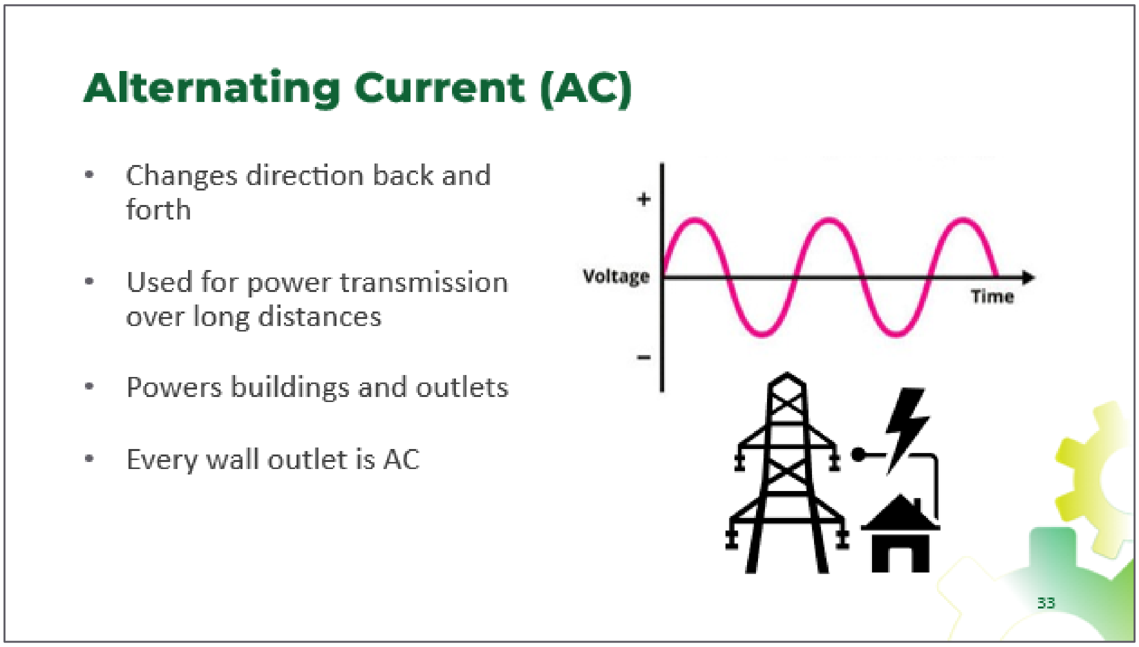
Notes:

- Now that we've talked about static electricity and voltage, let's talk about current electricity. **Current electricity** is the type of electricity we use every day.
- **Current** is the continuous movement of electrons through a conductor, usually a wire.
    - Unlike static electricity, it doesn't stay in one place — it moves along a complete path.
- That steady movement is what powers electrical devices. Everything from your phone to an electric train depends on current flowing.
- Current describes *how much* electric charge is moving through the wire. We measure current in amperes, or **amps**.
- You can think of it as *how many* electrons are moving through the circuit at a given time.
- A helpful way to picture this is with water.
- If voltage is like water pressure, current is the amount of water flowing through the pipe.
- A bigger pipe allows more water to flow.
- In the same way, a circuit with more current has more electrons moving through it.



Notes:

- DC is **predictable** and easy to use for small, portable devices.
- Direct current flows in **one direction** from the positive terminal to the negative. It is common in batteries, mobile devices, flashlights.
- For transit, DC is commonly used in automobiles, trucks and buses.



Notes:

- Alternating current **changes direction** periodically and is easier to transmit over distances.
- AC's ability to travel **long distances** is what makes the power grid work.
- AC is commonly used as power supply for household and industrial applications.
- Every outlet in your house is AC.

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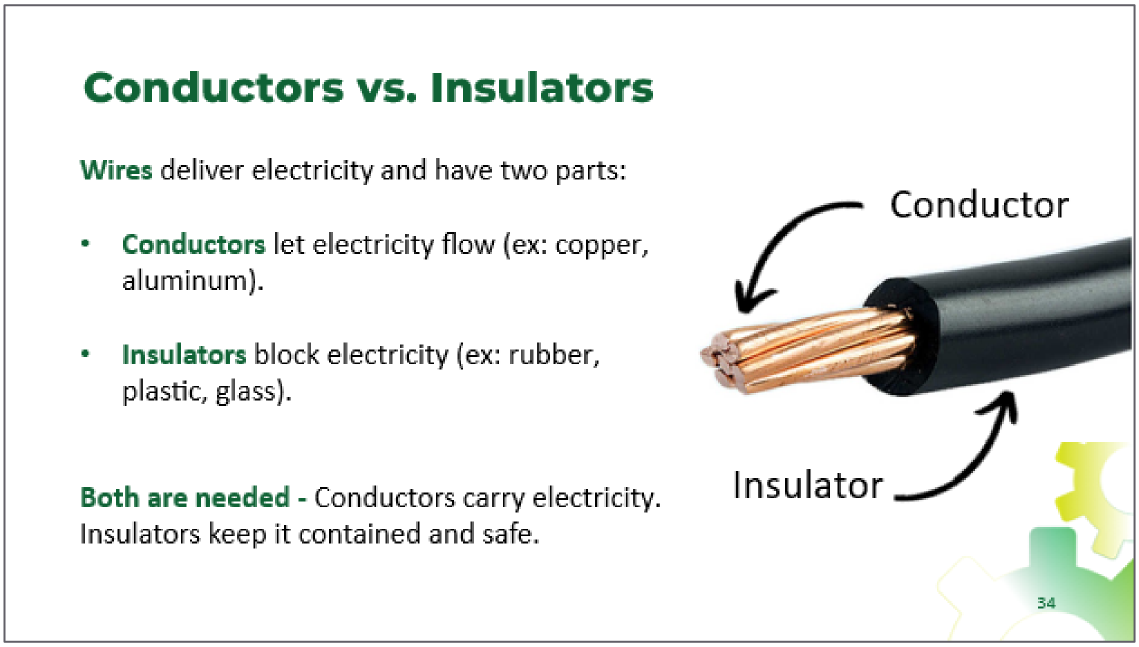

Notes:

- To control that flow, we have to control where electricity can move and where it can't.
- Whether electric charge builds up, flows smoothly, or is stopped altogether depends on the type of *material* it's in.
- **Conductors** are materials that allow electrons to move easily. Copper and aluminum are good conductors, which is why they're commonly used in wires and circuits.
- In transit systems, you see conductors in places like copper wiring, aluminum bus bars, and motor windings.
- These are the parts of the system designed to carry current.
- **Insulators** serve the opposite purpose. They resist the flow of electrons and keep electricity confined to the conductor. Materials like rubber, plastic, and glass are insulators.
- Without insulators, electricity would be unpredictable and dangerous.
- In transit environments, that includes wire insulation, connectors and plugs, gloves and mats, and rubber grommets.
- Conductors and insulators always work together. Conductors allow electricity to do useful work. Insulators keep that electricity contained and protect people and equipment.
- If a conductor wasn't insulated, electricity would be everywhere — not just where it's supposed to be.
- That's why damaged insulation is a safety issue, not just normal wear and tear.
- Mechanics rely conductors to make circuits work and insulators to keep those circuits safe.

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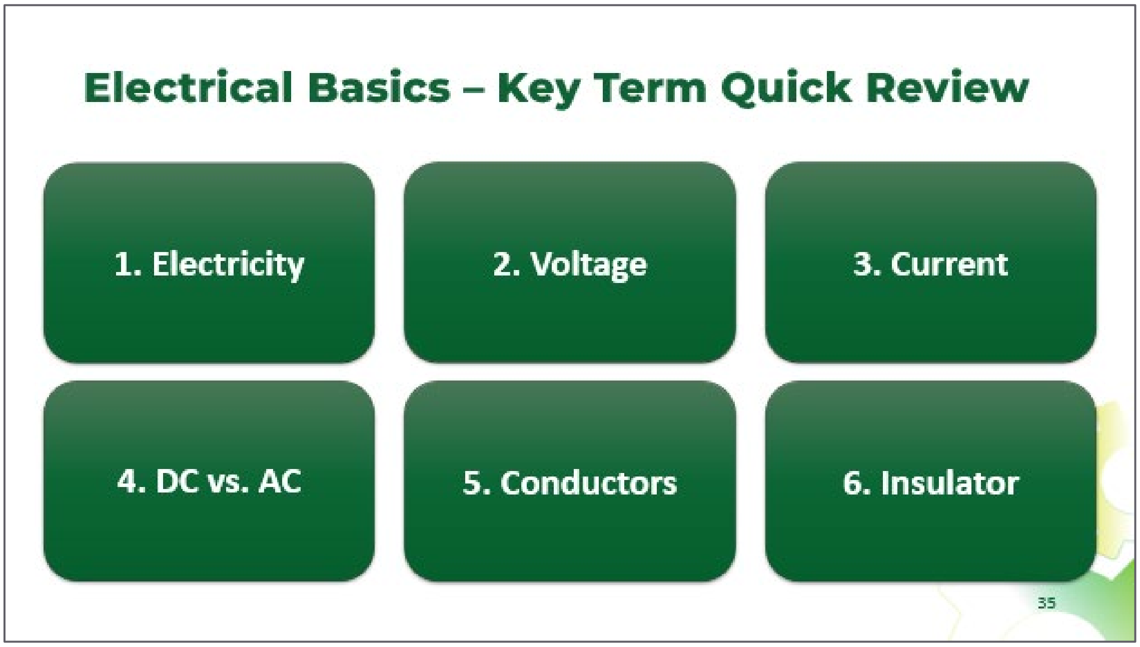
Electrical Basics – Key Term Quick Review
1. Electricity
2. Voltage
3. Current
4. DC vs. AC
5. Conductors
6. Insulator
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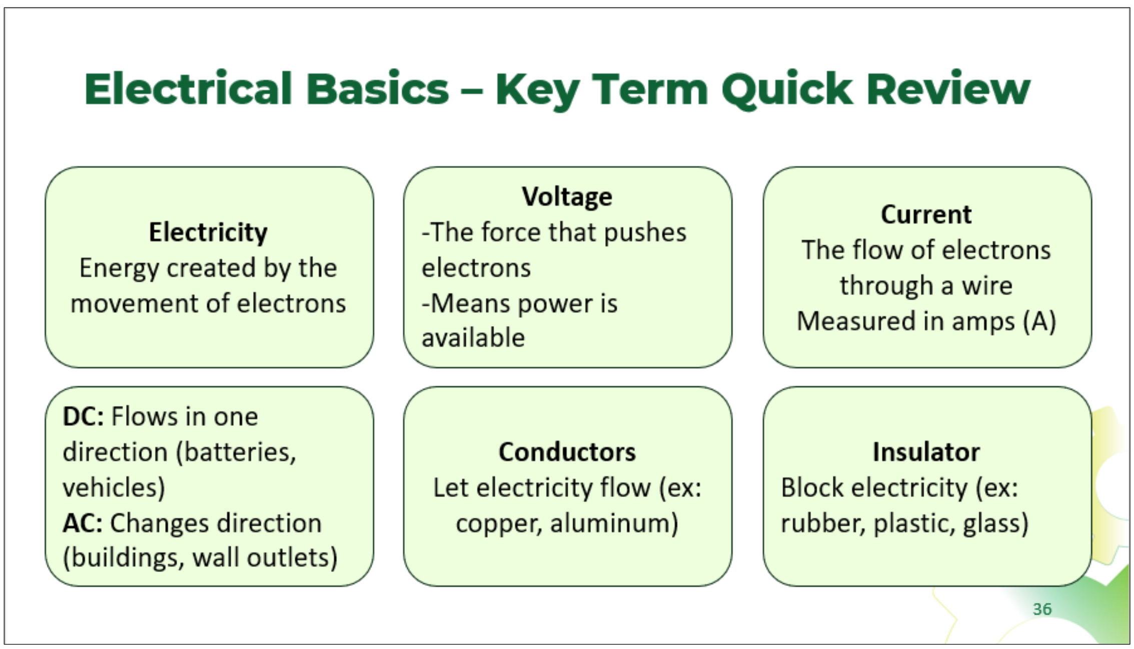
Electrical Basics – Key Term Quick Review
Electricity
Energy created by the movement of electrons
Voltage
-The force that pushes electrons
-Means power is available
Current
The flow of electrons through a wire
Measured in amps (A)
DC: Flows in one direction (batteries, vehicles)
AC: Changes direction (buildings, wall outlets)
Conductors
Let electricity flow (ex: copper, aluminum)
Insulator
Block electricity (ex: rubber, plastic, glass)
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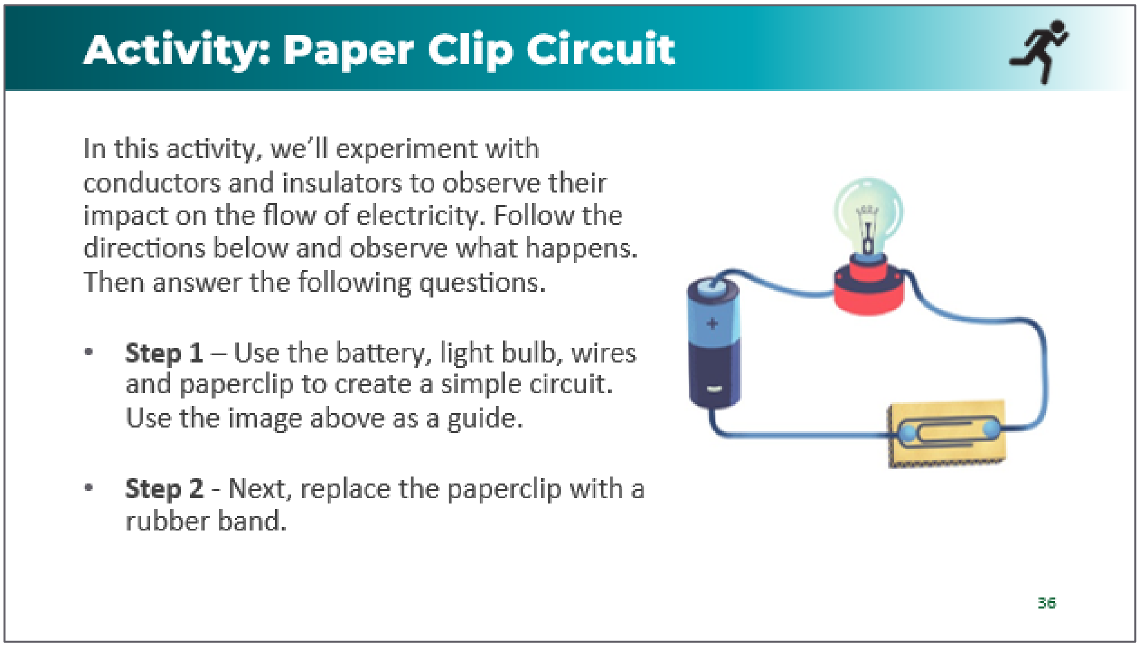


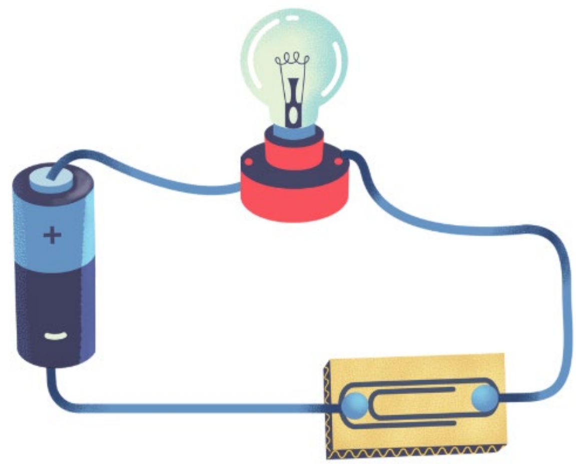
Notes:

- In this activity, we'll experiment with conductors and insulators to observe their impact on the flow of electricity. Follow the directions below and observe what happens. Then answer the following questions.
- First, use the battery, light bulb, wires and paperclip to create a simple circuit. Use the image above as a guide.
- Next, replace the paperclip with a rubber band.
- Once you've finished the activity, go ahead and answer these follow up questions:
    1. Why did adding the paperclip make the light bulb turn on?
    2. Why did adding the rubber band not work?

Activity

Paper Clip Circuit

In this activity, we'll experiment with conductors and insulators to observe their impact on the flow of electricity. Follow the directions below and observe what happens. Then answer the following questions.



Materials:

- D-cell battery and holder
- Lightbulb (1-5 Volts) and socket
- 3 Jumper Wires
- 3x2 inches of cardboard
- 1 Paper Clip
- 1 Rubber band

Directions:

- **Step 1** – Use the battery, light bulb, jumper wires and paper clip to create a simple circuit. Connect one jumper wire to each end of the paper clip, then connect the remaining ends of the jumper wires to the battery terminals to complete the circuit.
- **Step 2** - Next, replace the paperclip with a rubber band.

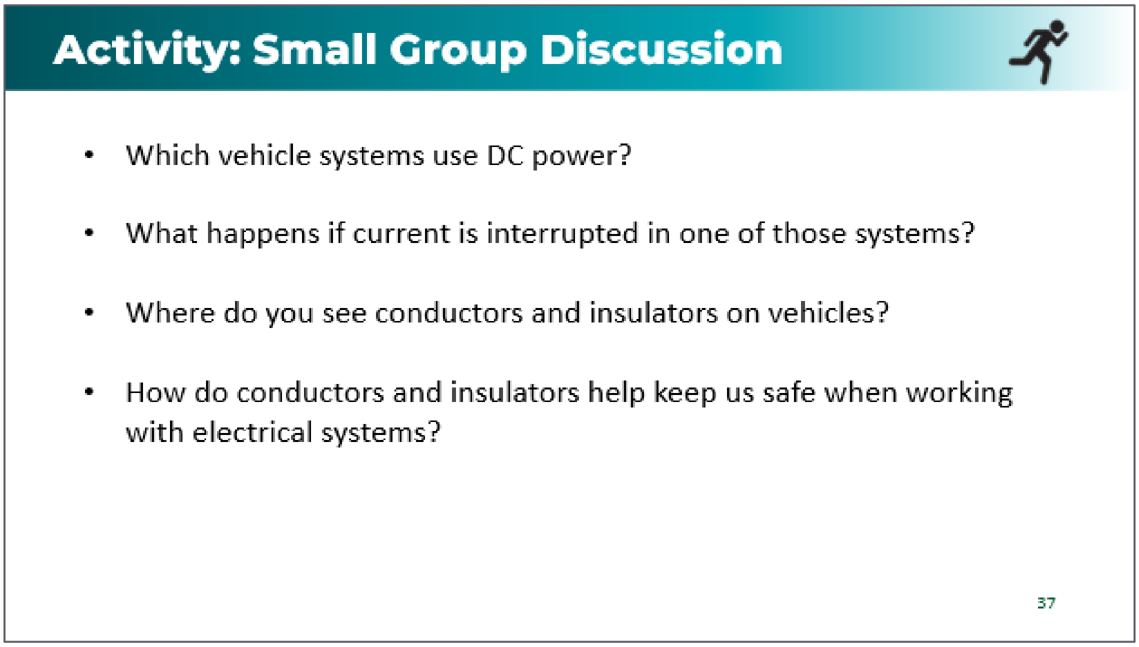
Follow up questions:

Use the space below to write your answers to the following questions:

1. Why did adding the paper clip make the light bulb turn on?

2. Why did adding the rubber band not work?

Notes:


Activity: Small Group Discussion
• Which vehicle systems use DC power?
• What happens if current is interrupted in one of those systems?
• Where do you see conductors and insulators on vehicles?
• How do conductors and insulators help keep us safe when working with electrical systems?
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Knowledge Check

What is the primary difference between static and current electricity?

A) Static electricity is more dangerous

B) Static electricity involves flowing charges

C) Static electricity is stored; current electricity flows continuously

D) Current electricity is natural; static is man-made

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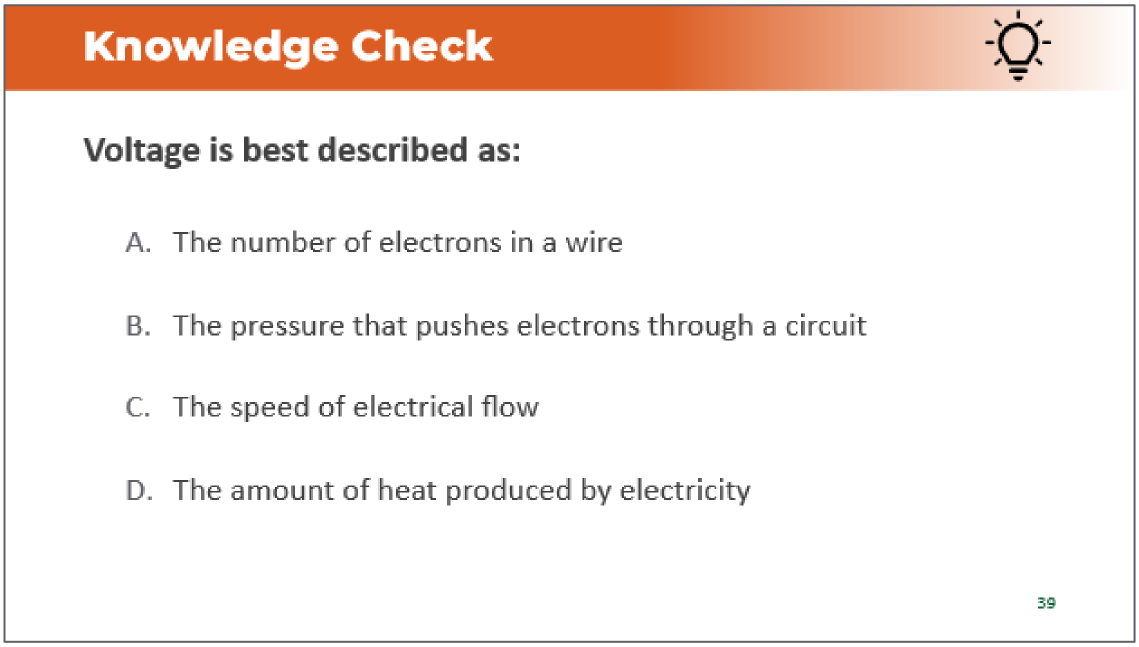
Knowledge Check
Voltage is best described as:
A. The number of electrons in a wire
B. The pressure that pushes electrons through a circuit
C. The speed of electrical flow
D. The amount of heat produced by electricity
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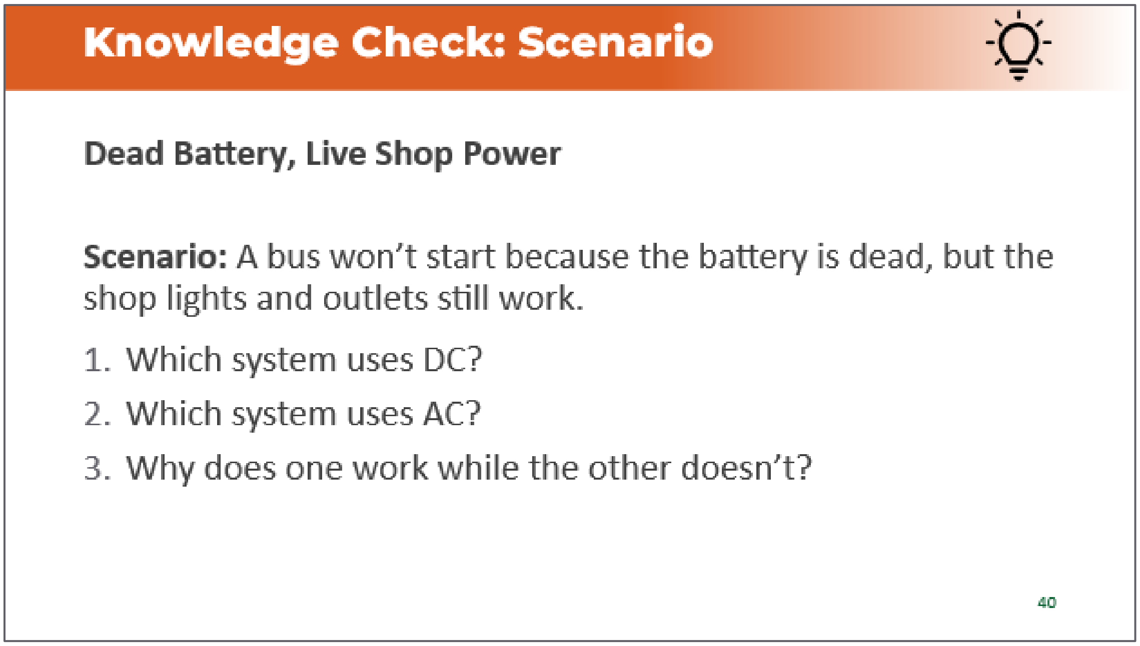
Knowledge Check: Scenario
Dead Battery, Live Shop Power
Scenario: A bus won’t start because the battery is dead, but the shop lights and outlets still work.
1. Which system uses DC?
2. Which system uses AC?
3. Why does one work while the other doesn’t?
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Knowledge Check

Which of the following describes current?

A. The build-up of charge on an object

B. The continuous flow of electrons through a conductor

C. The resistance of a material

D. The measure of electrical pressure

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Knowledge Check

Which of the following materials is a good conductor of electric current?

A. Rubber

B. Wood

C. Copper

D. Glass

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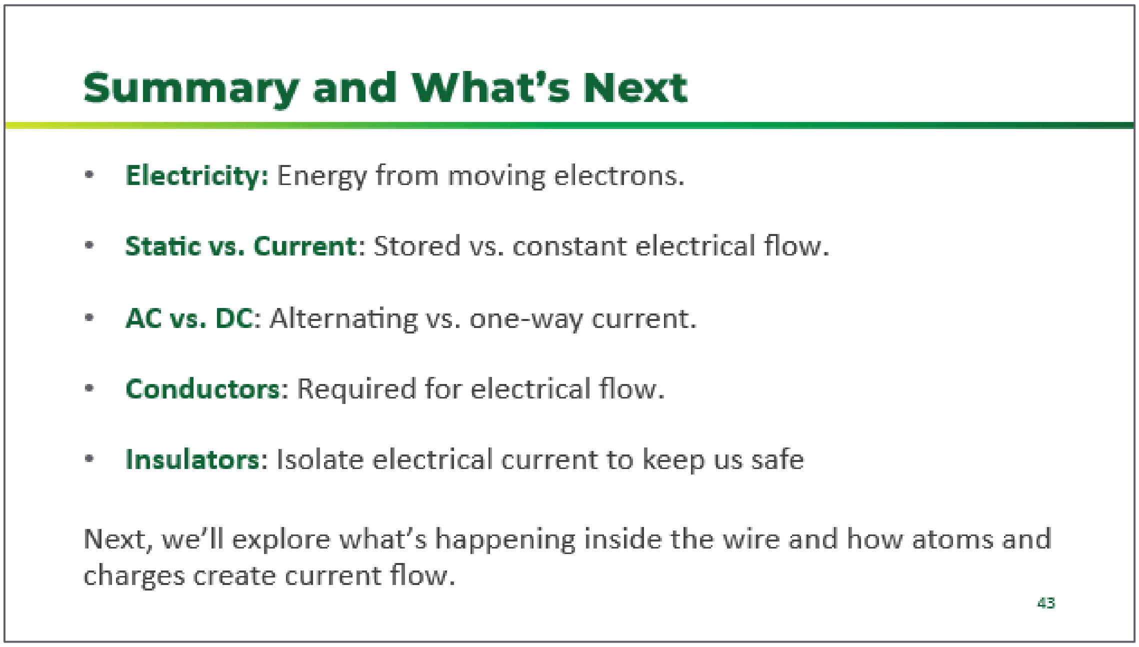

Notes:

- Let's wrap up this section with a few quick takeaways. These are the terms that will show up in our electrical discussions.
    - **Electricity** is a form of energy created by the **movement of electrons**.
    - **Static electricity** involves **stationary charges**, while **current electricity** involves **flowing charges** through a circuit.
    - There are two types of current:
    - **AC (Alternating Current)** – changes direction.
    - **DC (Direct Current)** – flows in one direction.
    - To move electricity safely, we use **conductors** to carry current and **circuits** to control where it flows.
- These core ideas form the foundation for everything else you'll learn in electrical systems.
- Next, we'll explore what's happening *inside* the wire and how atoms and charges create current flow.

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Notes:

- We've talked about electricity as energy. Now let's look closer - what's actually moving inside those wires?

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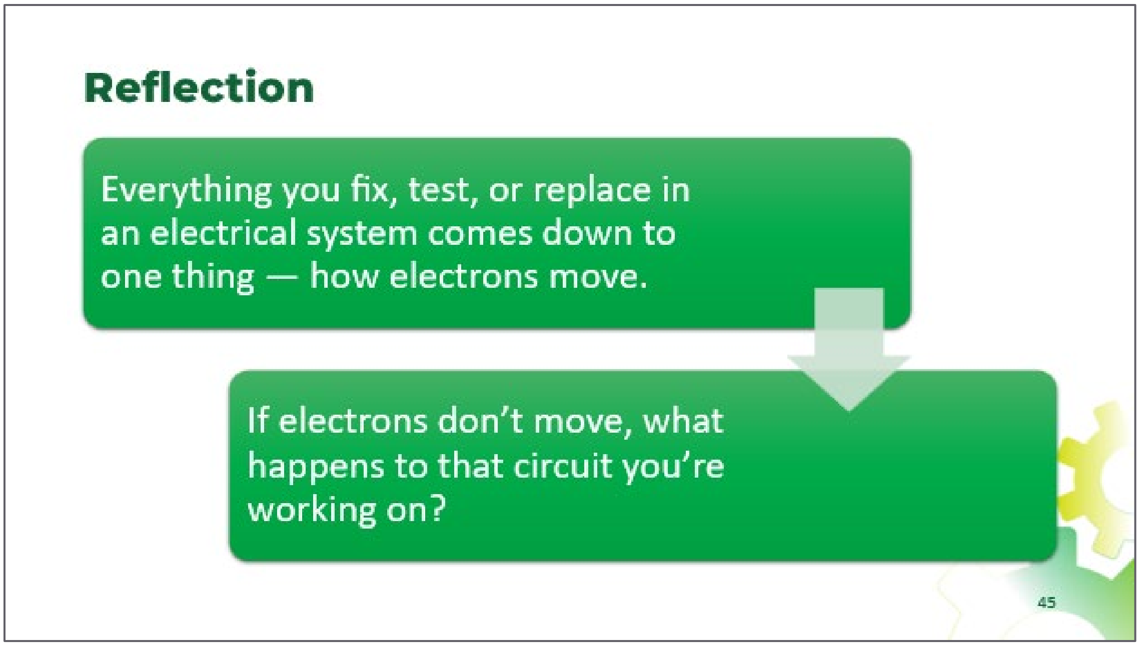
Reflection
Everything you fix, test, or replace in an electrical system comes down to one thing — how electrons move.
If electrons don't move, what happens to that circuit you're working on?
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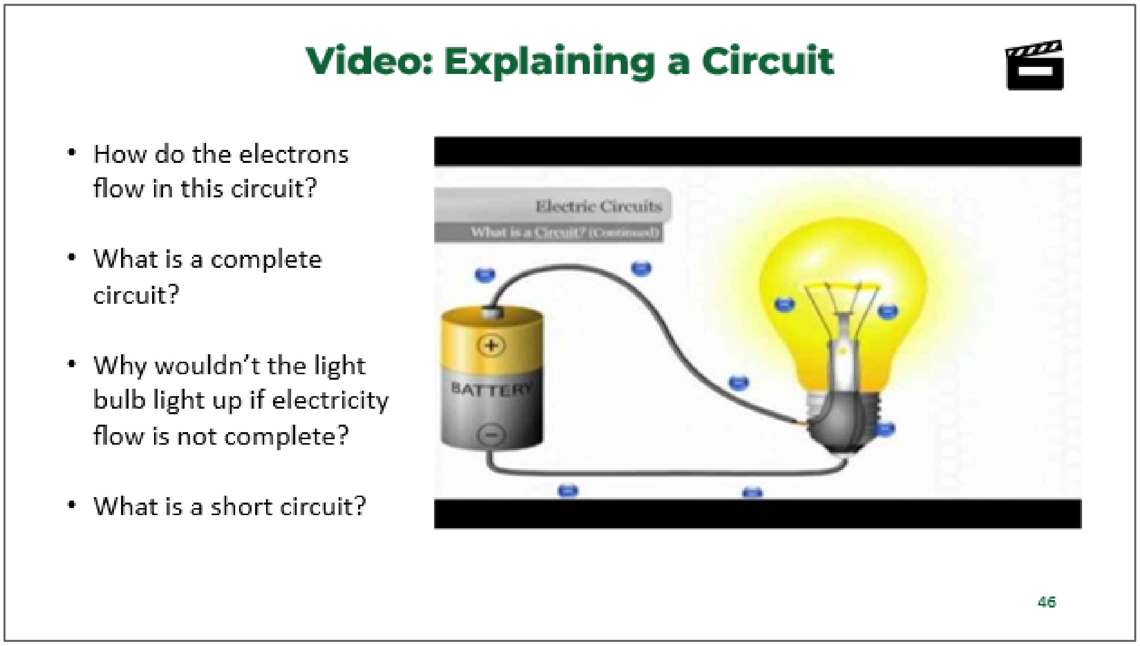
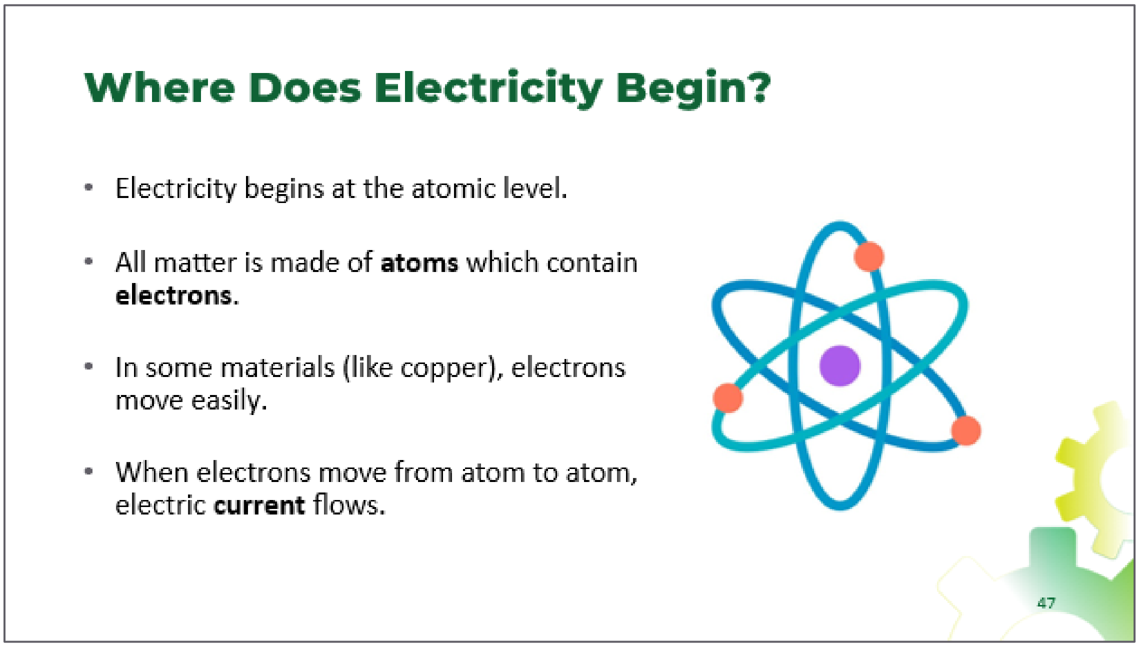


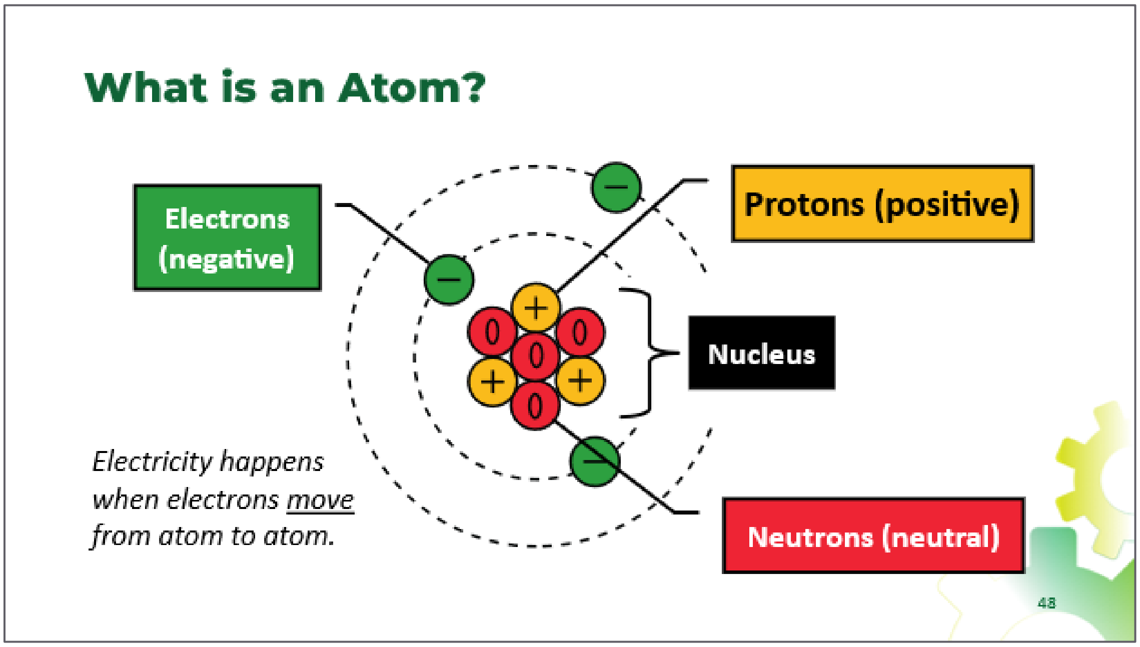
Notes:

- After watching the video, answer the following questions:
  a) What is a complete circuit?
  b) Why wouldn't the light bulb light up if electricity flow is not complete?
  c) How does electricity flow in a circuit?
  d) What is a short circuit?
- *Video Source:* Region 10 Education Service Center. (2012, February 13). *Explaining an electrical circuit* [Video]. YouTube. https://www.youtube.com/watch?v=VnnpLaKsqGU



Notes:

- To understand electricity, we have to start very small because electricity begins at the atomic level.
- Everything around us is made of atoms. Inside atoms are tiny particles called electrons.
- In some materials, like copper, electrons can move easily. Those materials are especially useful in electrical systems and in transit.
- When electrons move from atom to atom, electric current flows.
- That movement is what allows electricity to do useful work.
- Electricity doesn't just appear — it starts with electrons moving at the atomic level.



Notes:

- An atom is the smallest piece of anything, a subatomic piece of all matter.
- Everything around us - tools, wires, buses, and even us is made of atoms. You can't see atoms but they're the basic building blocks of everything.
- You can think of an atom like a tiny solar system:
  - In the center is the **nucleus**. The nucleus is an atom's dense center, stays still and is where all the heavy parts of an atom live:
  - **Protons** are positively charged particles of an atom (labeled with a "+ sign") and are fixed in the nucleus
  - **Neutrons** are particles of the atom with no charge (labeled with a zero). These make up an atom's mass, but do not affect its charge.
  - Spinning around the outside are **electrons**, which are the smallest particles within an atom, are light compared to protons and neutrons, have a negative charge (labeled with a "–" sign) and move fast.
  - When those electrons move from one atom to another, that's electricity. Electrons are mobile and reside outside an atom's nucleus/center.
- It's important to note, the elements that make up electricity are extremely small, and wires carry a countless number invisible to the eye.
- **When atoms gain or lose electrons, they can create electricity** — that's what makes current flow through a wire.

- In short: Atoms are the tiny building blocks of everything, and the movement of their electrons is what gives us electricity.

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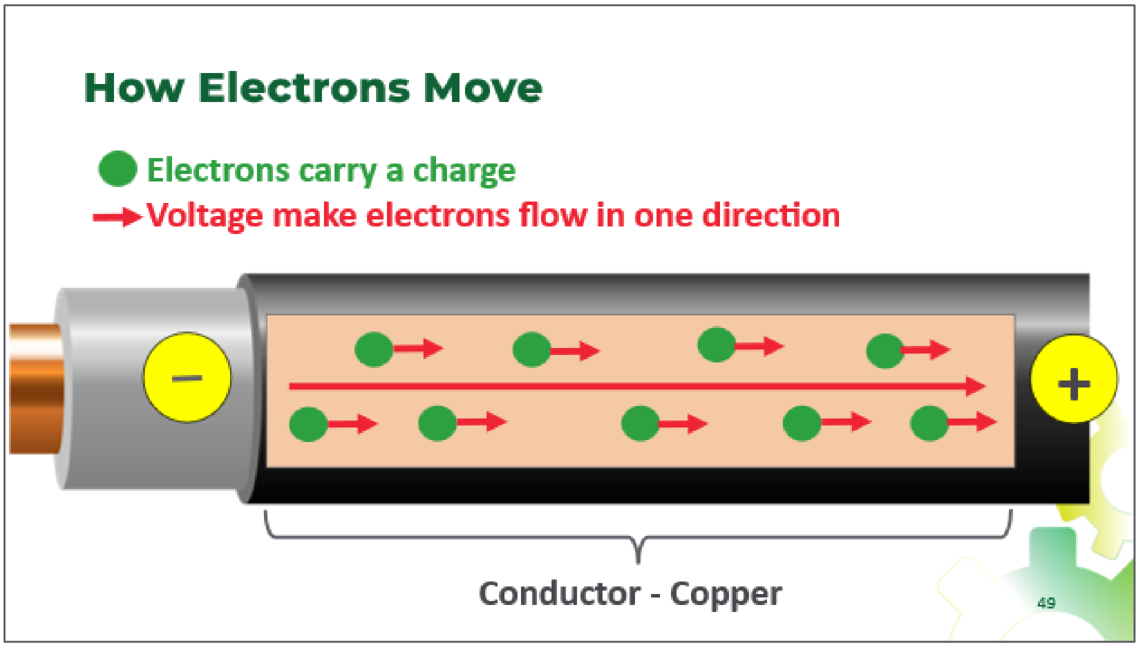

Notes:

- Electric current happens when electrons *move* through a material, and that movement starts with a push called **voltage**.
- When voltage is applied, electrons begin moving, and that movement is what we call electric current.
- Electrons actually move from negative to positive, but by long-standing convention, we describe current as flowing from positive to negative. It's important to remember that difference as we talk about circuits.
- A helpful way to picture this is with water.
  - **Voltage** is like a pump creating pressure, the **wire** acts like the pipe, and **current** is the flow of water through that pipe.
- In metals like copper or aluminum, some electrons are free to move from atom to atom. When voltage is applied, those free electrons begin moving in one direction, creating current.
- We measure current in amperes, or amps, similar to how we measure how much water flows through a pipe.
- This *movement* of electrons is what makes electricity useful. It's what allows tools to run, lights to turn on, and trains to move.
- Voltage sources are what make electrons start moving. In transit systems, that might be a battery pushing electrons to crank an engine, an alternator pushing electrons back into a battery, or inverters and control modules pushing electrons through different circuits.
- If electrons can't move, the system won't work. Motors won't spin, relays won't close, and circuits won't complete.

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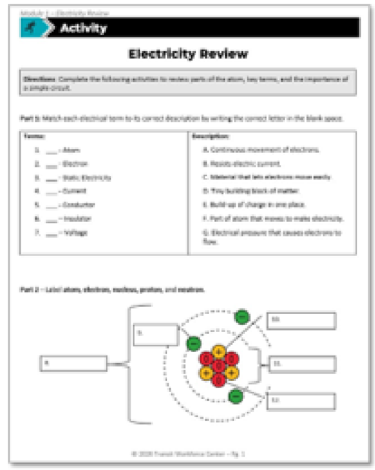
Activity: Electricity Review

Directions: Complete the following activities to review parts of the atom, key terms, and the importance of a simple circuit.

Part 1: Matching electrical terms

Part 2: Labeling the atom

Part 3: Simple circuit review



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Activity

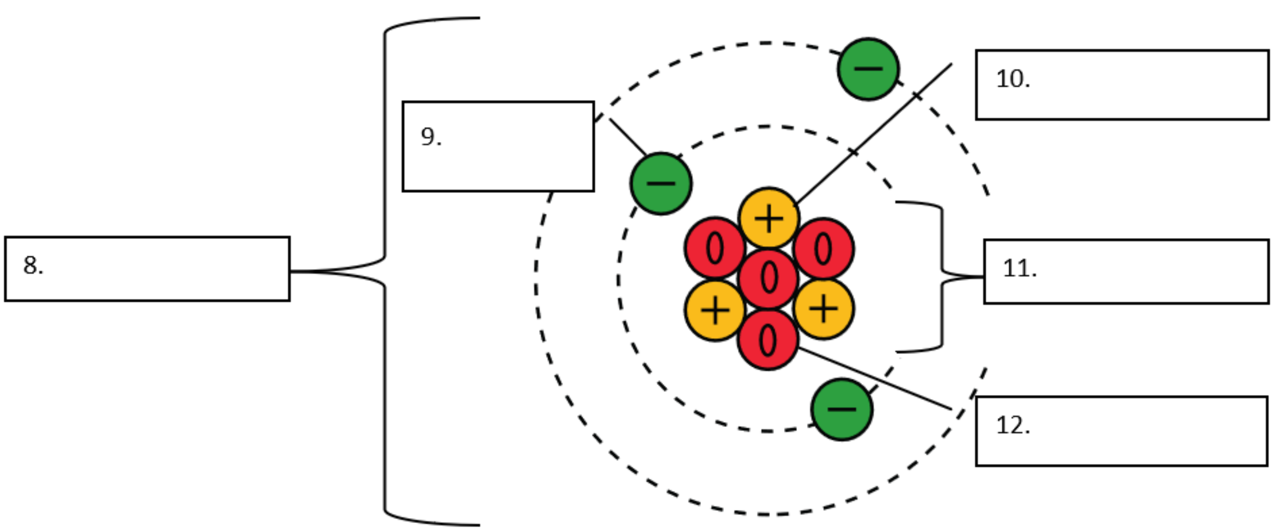
Electricity Review

Directions: Complete the following activities to review parts of the atom, key terms, and the importance of a simple circuit.

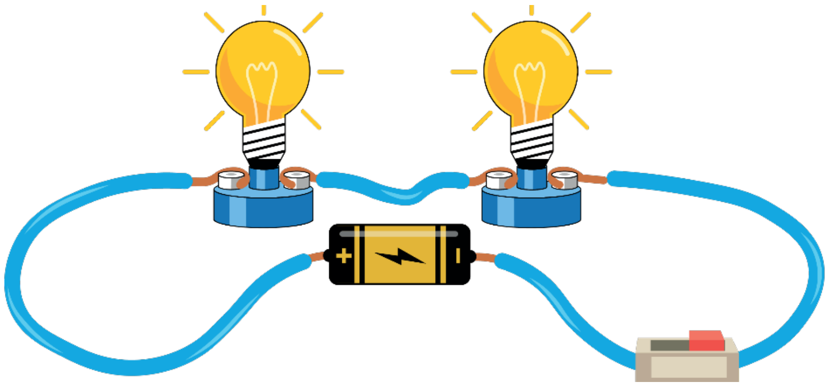
Part 1: Match each electrical term to its correct description by writing the correct letter in the blank space.

Terms:	**Description:**
1. ___ - Atom	A. Continuous movement of electrons.
2. ___ - Electron	B. Resists electric current.
3. ___ - Static Electricity	C. Material that lets electrons move easily.
4. ___ - Current	D. Tiny building block of matter.
5. ___ - Conductor	E. Build-up of charge in one place.
6. ___ – Insulator	F. Part of atom that moves to make electricity.
7. ___ – Voltage	G. Electrical pressure that causes electrons to flow.

Part 2 – Label **atom, electron, nucleus, proton,** and **neutron.**



Part 3: Answer the following questions to review the importance of a simple circuit.



13. Draw and arrow around the circuit to show which way the path of electricity flows.

14. Label each part of the circuit:
    a. Power source
    b. Conductors
    c. Load
    d. Switch
    e. Positive (+) terminal
    f. Negative (–) terminal

15. Which part pushes electrons? _______________

16. Which part uses the energy? _______________

17. Which parts provide a path? _______________

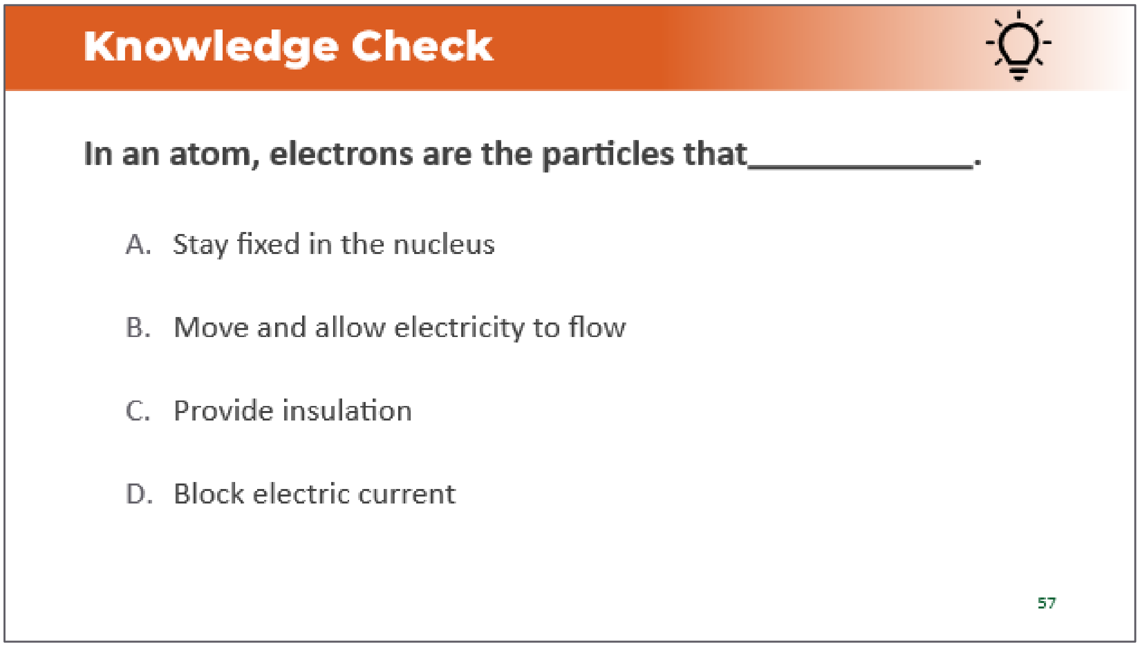
18. Are electrons created by the battery?

19. Where are electrons already present?

20. What happens if the switch is closed? What changes when the switch is opened?

21. If we flipped the battery, would the light still turn on? Why or why not?

22. How is this circuit different from the paper clip circuit we made earlier in our lesson? What's the same?


Knowledge Check
In an atom, electrons are the particles that____________.
A. Stay fixed in the nucleus
B. Move and allow electricity to flow
C. Provide insulation
D. Block electric current
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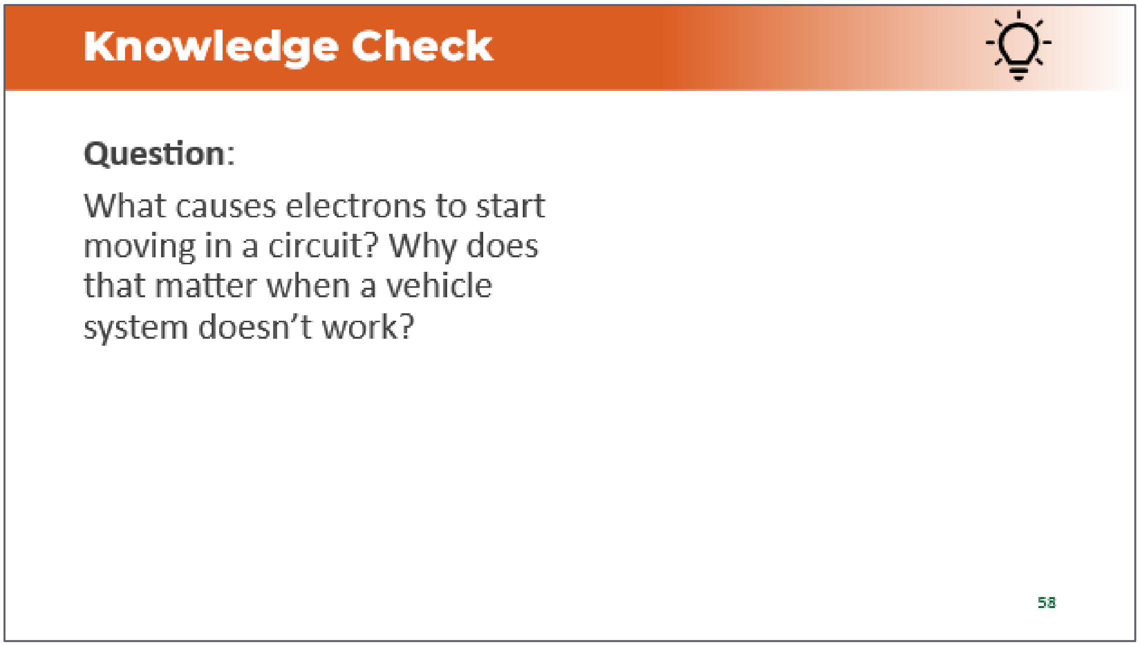
Knowledge Check
Question:
What causes electrons to start moving in a circuit? Why does that matter when a vehicle system doesn't work?
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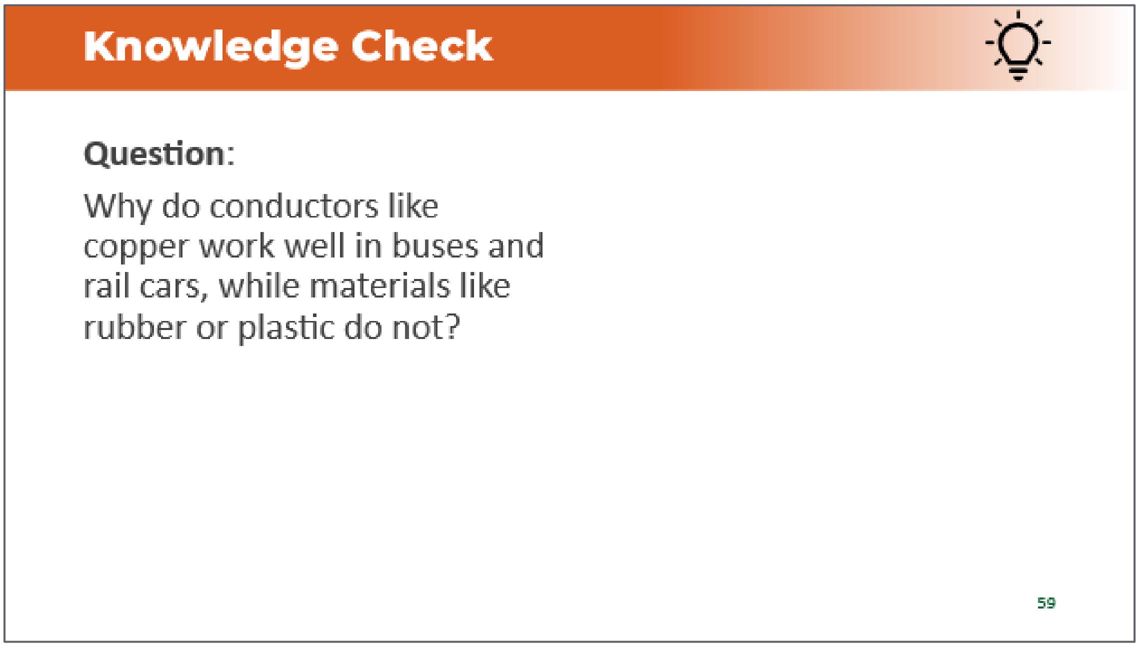
Knowledge Check
Question:
Why do conductors like copper work well in buses and rail cars, while materials like rubber or plastic do not?
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Knowledge Check

Question:

What signs or symptoms tell you that electrons aren't flowing properly? What does that tell you about the circuit?

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Knowledge Check

Question:

Where on a bus or train is electron flow critical? What happens when that flow is interrupted?

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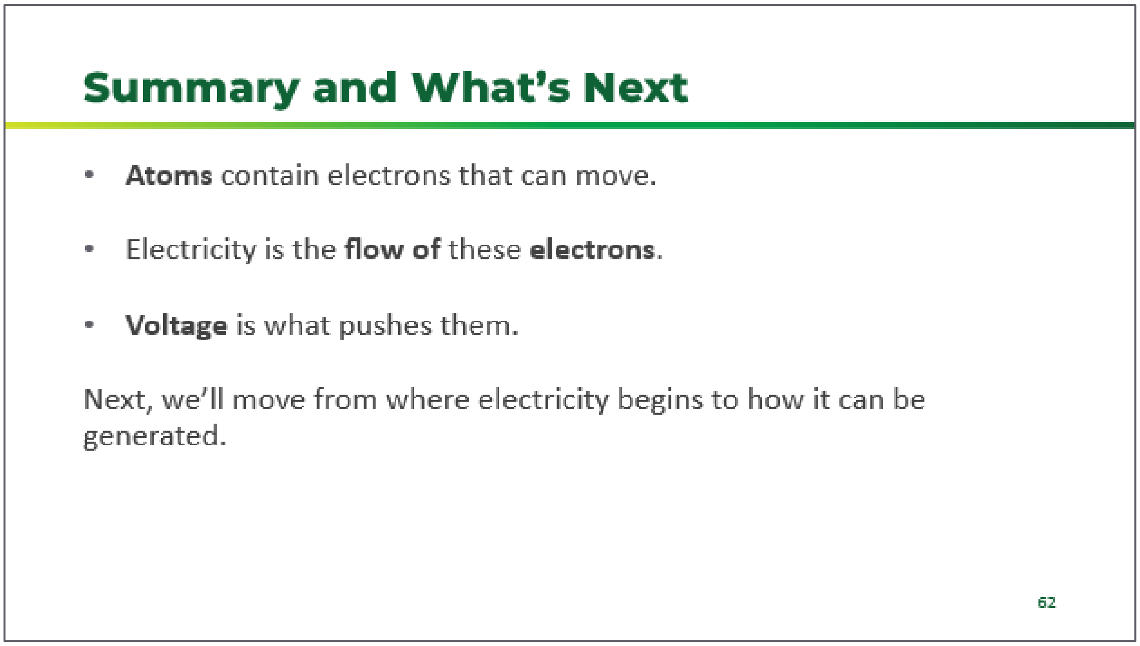

Notes:

- Let's review the key concepts from this module:
- **Atoms** contain electrons that can move.
- Electricity is the **flow of** these **electrons**.
- **Voltage** is what pushes them.
- **What's Next?** We'll move from where electricity begins to how it can be generated.

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Notes:

- We know *what* electricity is — now let's see *how we make it.*
- Let's see how we generate and deliver that energy to use it safely.

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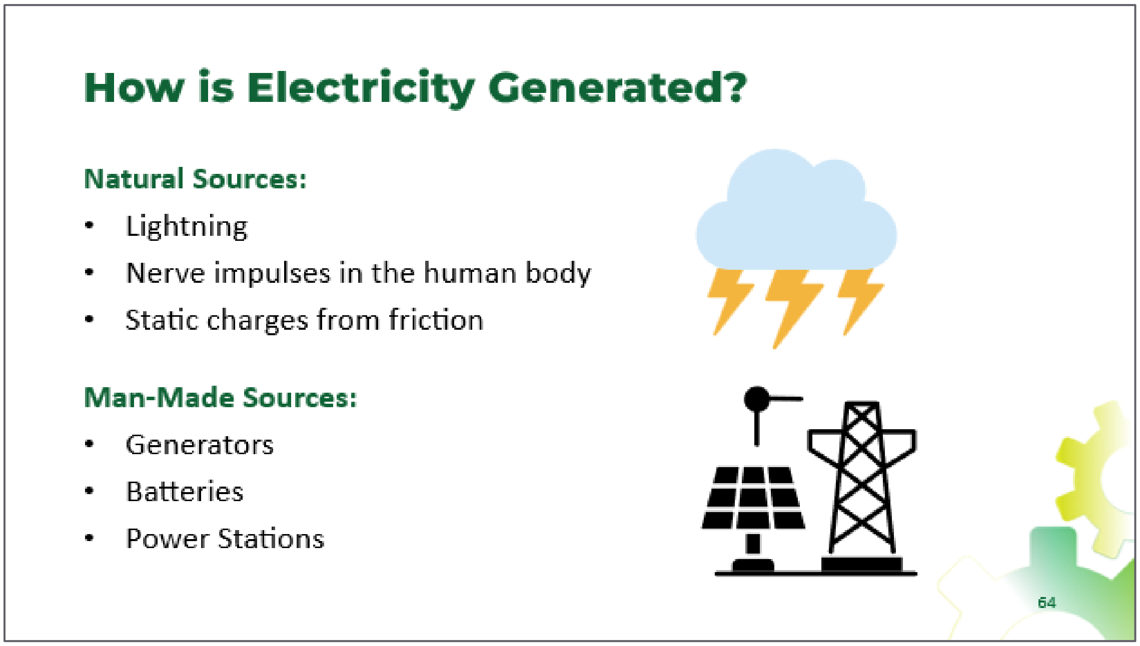

Notes:

- Electricity can come from both **natural** and **man-made** sources.
- **Natural sources** include:
  - Lightning, which is a massive buildup and release of static electricity in the atmosphere.
  - Electric eels, which generate electric fields to hunt or defend themselves.
  - Static electricity from friction, like rubbing socks on carpet or combing dry hair.
- **Man-made sources** are what we rely on to power the modern world:
  - Generators, which use magnets and motion to produce electricity.
  - Batteries, which convert chemical energy into electrical energy.
  - Power stations, which generate electricity on a large scale—using wind, water, fossil fuels, or nuclear energy.
- No matter the source, the goal is the same: **move electrons to produce usable energy**.

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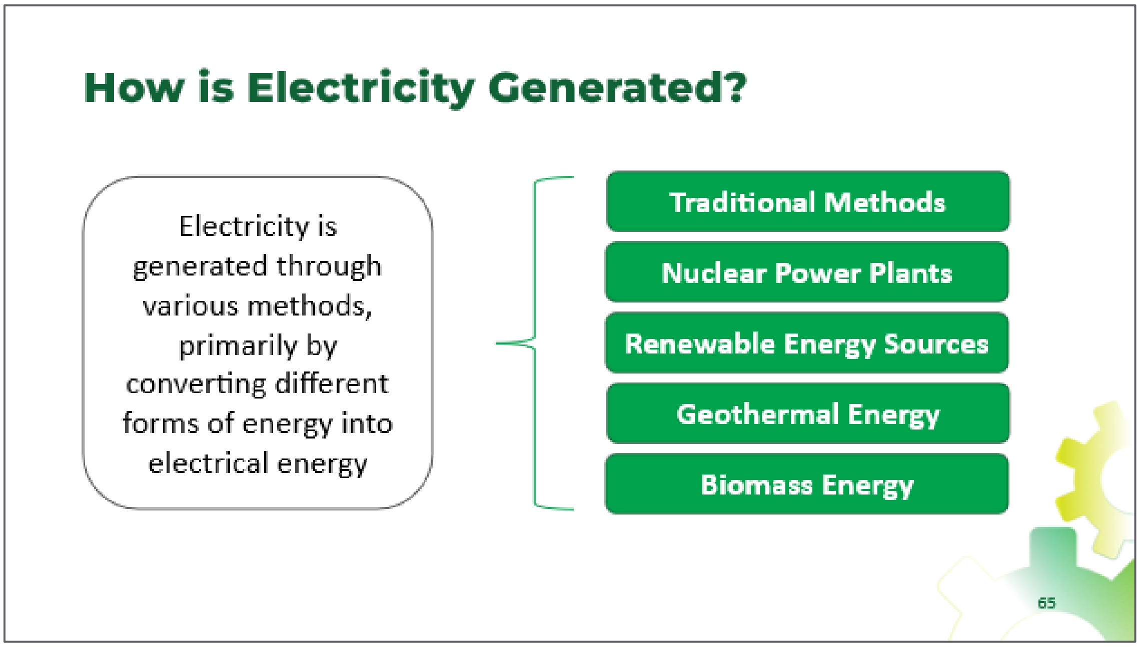

Notes:

- Electricity is generated by converting other forms of energy—like motion, heat, or sunlight—into electrical energy.
- There are several ways we do this:
    1. Traditional Method
    2. Nuclear Power Plants
    3. Renewable Energy Sources
    4. Geothermal Energy
    5. Biomass Energy
- In each case, the goal is the same: **turning energy into motion**, and **motion into electricity** which is then distributed through power grids to homes, businesses, and industries.

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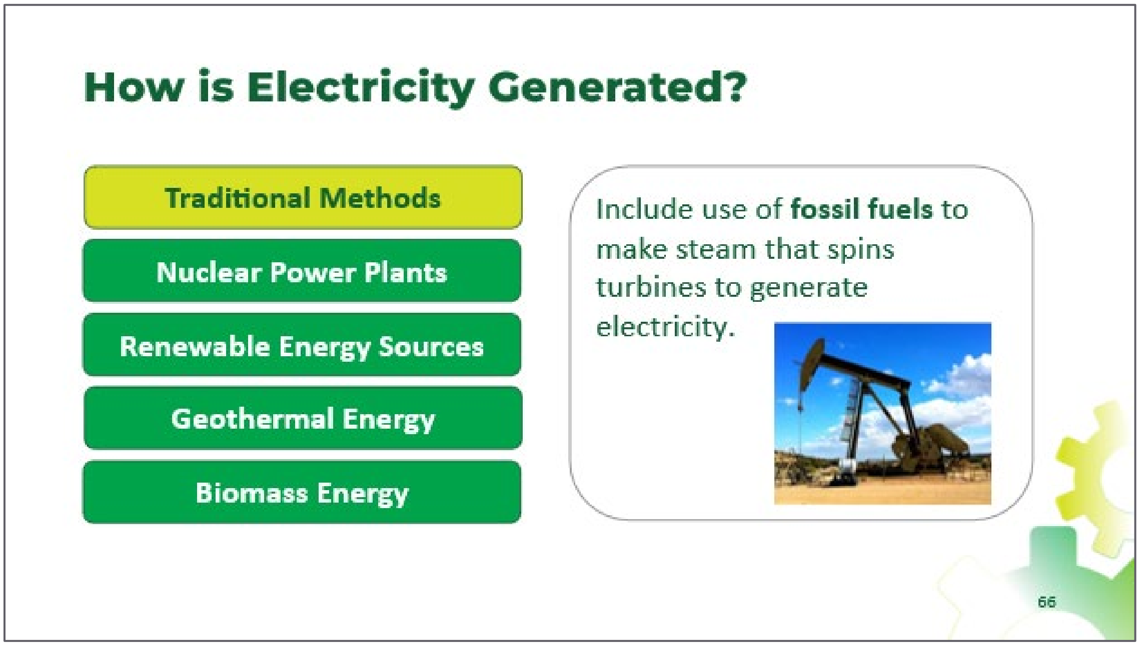
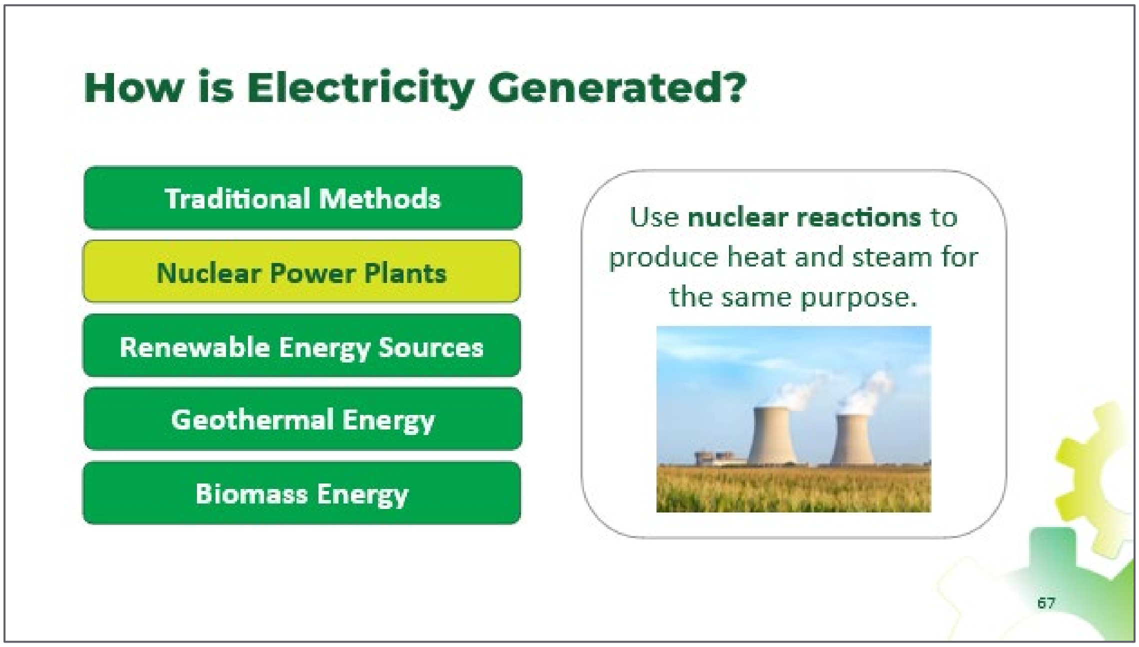


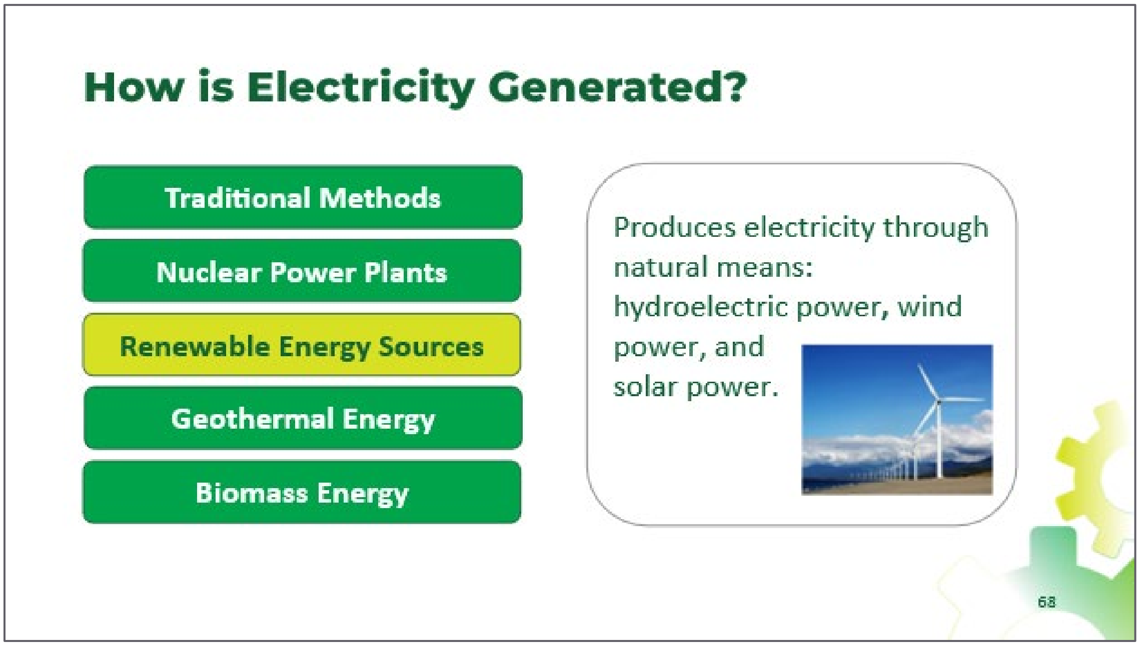
Notes:

- Traditional methods of generating electricity rely on fossil fuels—like coal, natural gas, and oil.
- Here's how it works:
    - These fuels are burned, producing heat.
    - That heat is used to boil water into steam.
    - The steam spins a turbine, which is connected to a generator that produces electricity.



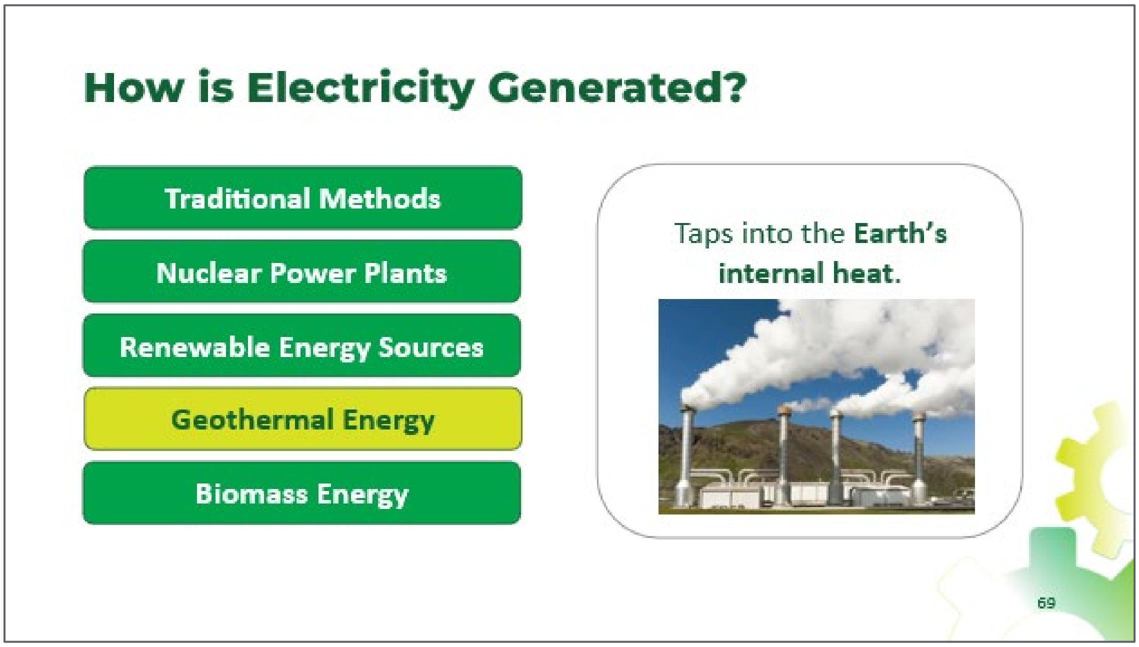
Notes:

- Nuclear power plants use nuclear reactions—specifically, fission—to produce heat for the same purpose as traditional plants.
- That heat boils water into steam.
- The steam spins a turbine.
- And the turbine powers a generator to create electricity.



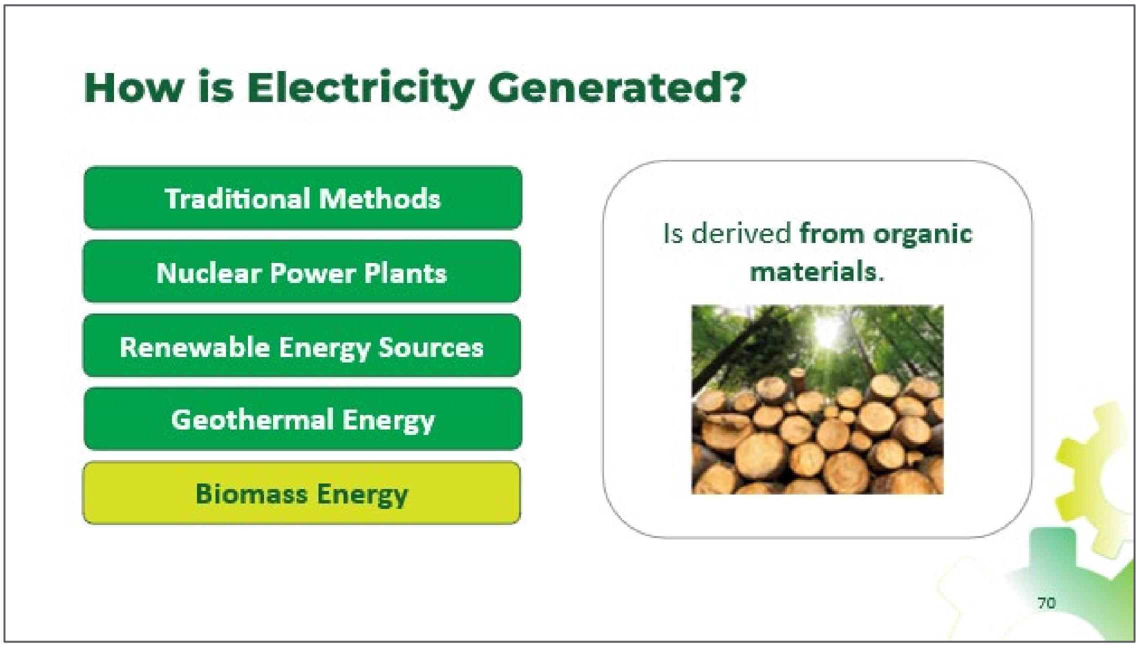
Notes:

- Renewable energy sources are becoming more important as we shift toward cleaner, sustainable power.
- These methods don’t burn fuel—instead, they capture natural energy from the environment:
  - Hydroelectric power uses the force of flowing water to spin turbines.
  - Wind power turns wind turbines, converting motion into electricity.
  - Solar power uses photovoltaic panels to convert sunlight directly into electrical energy.



Notes:

- Geothermal energy taps into the Earth's natural internal heat—energy stored beneath the surface.
- Wells are drilled into hot underground reservoirs.
- That heat is used to produce steam.
- And the steam drives a turbine connected to a generator, just like in other power plants.



Notes:

- Biomass energy is generated by burning organic materials, like wood, crop waste, or even landfill gases.
- These materials are rich in stored chemical energy from the sun.
- When burned, they release heat, which is used to produce steam and generate electricity, just like fossil fuels.

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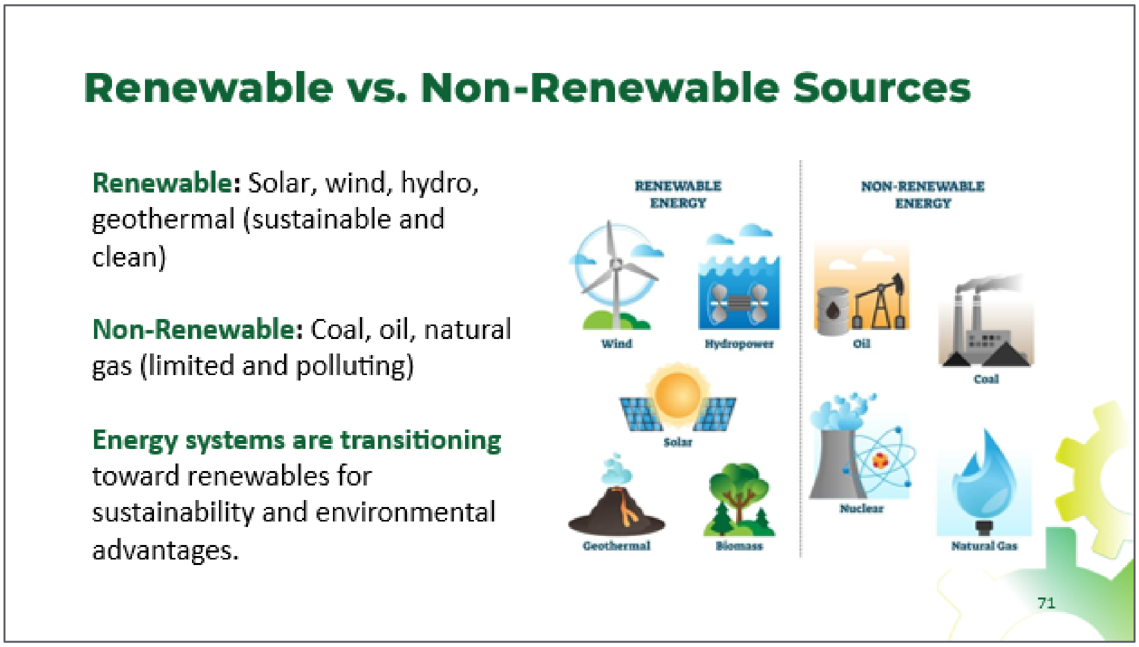

Notes:

- The future of power is clean, but today's grid still relies heavily on fossil fuels.
- Renewable sources include solar, wind, hydroelectric, and geothermal. These are clean, sustainable, and naturally replenished.
- Non-renewable sources include coal, oil, and natural gas. These are limited resources and often produce pollution and greenhouse gases.
- Because of climate concerns and resource limits, energy systems around the world are shifting toward renewables—not only for sustainability, but also for long-term reliability.

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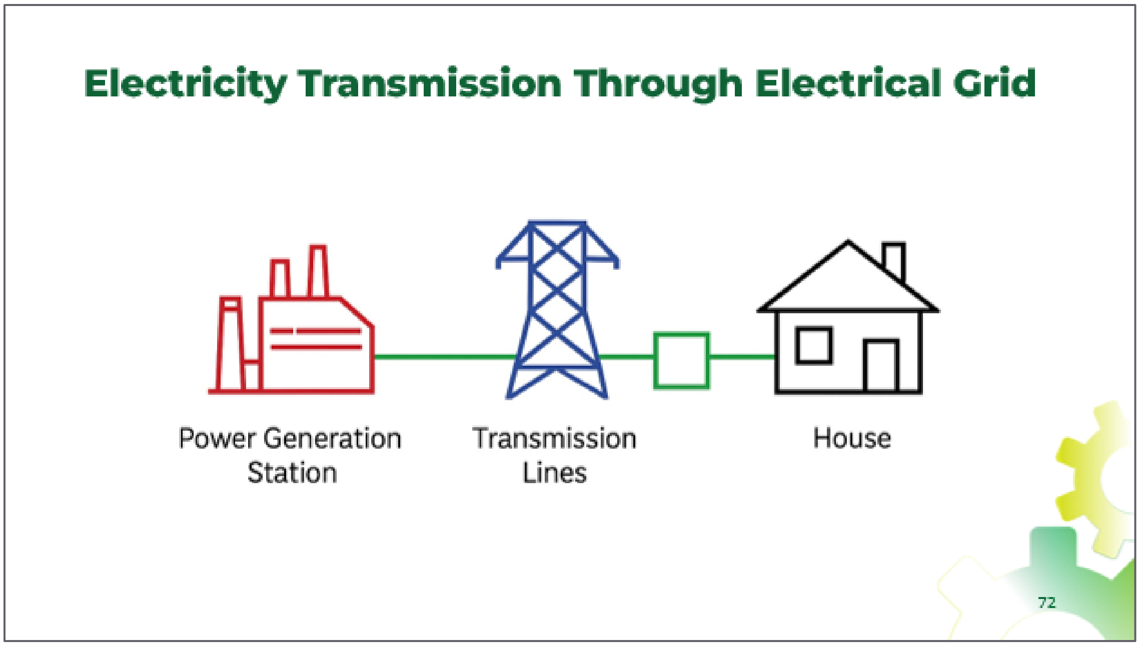

Notes:

- Once electricity is generated, it doesn't go straight to your home—it travels through a system called the **electrical grid**.
- This entire journey happens in seconds—powering your lights, appliances, and electronics almost instantly.
- Electricity is often generated in centralized locations because large power plants can produce electricity more efficiently and reliably, then transmit it over long distances to where it's needed.
- The journey depicted on this slide **represents AC transmission**.

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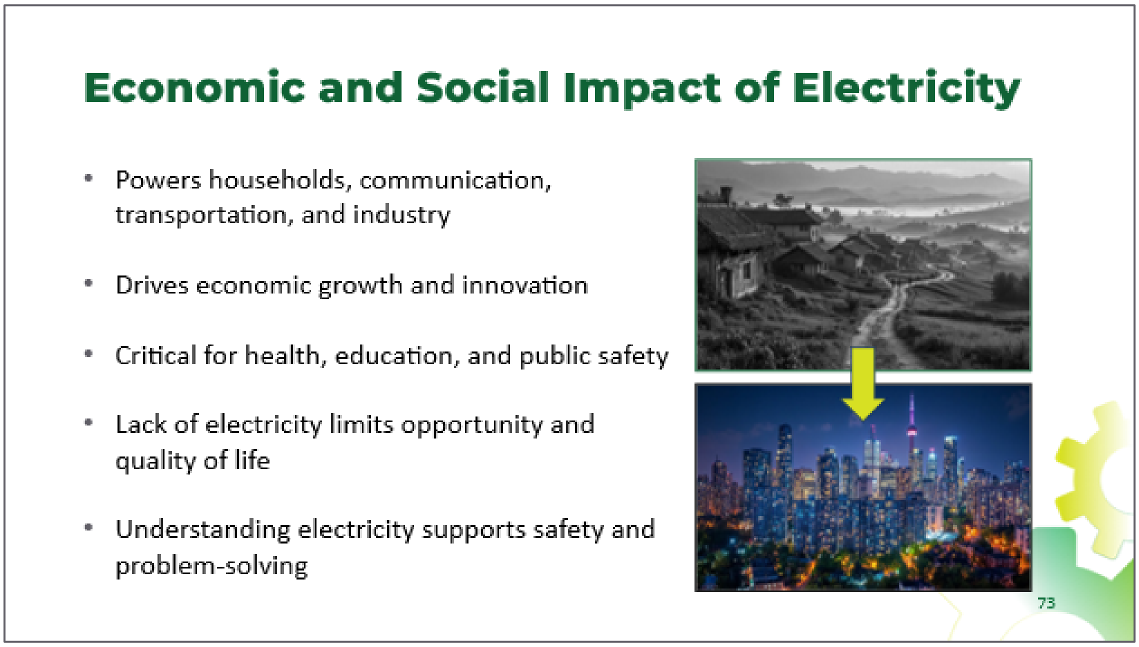

Notes:

- Electricity is one of the most important foundations of modern life.
- It powers everything—from homes and schools, to hospitals, factories, and transit systems. Without it, most modern systems can't function.
- Access to electricity is directly tied to economic growth and development. Countries with reliable electrical systems can support industry, education, communication, and healthcare.
- Where electricity is unavailable or unreliable, it becomes much harder to learn, earn, or stay safe—making access to electricity a key issue for equity and opportunity worldwide.
- In developing electricity, there is waste generated. There is the nuclear waste of spent fuel and waste in the form of emissions from burning fossil fuels.
- This is why wind and solar are becoming popular because they eliminate the waste.

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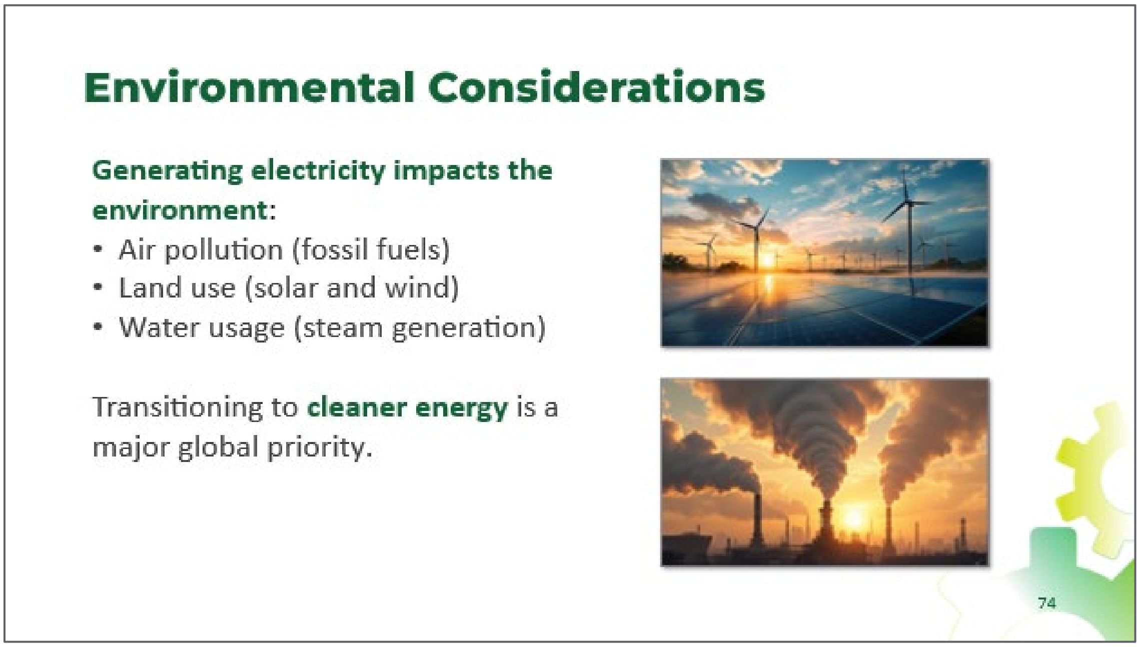

Notes:

- Being energy-aware also means understanding our responsibility to reduce harm.
- While electricity is essential, the way we generate it has real environmental consequences.
  a) Fossil fuel plants release air pollutants and greenhouse gases that contribute to climate change and poor air quality.
  b) Solar farms and wind turbines are much cleaner, but they often require large areas of land, which can affect wildlife and natural habitats.
  c) Some power plants, including nuclear and fossil fuel stations, also use a lot of water for cooling, which can strain water resources.
- That's why there's a global push to transition to cleaner, more sustainable energy sources—reducing harm while still meeting our growing energy needs.
- In summary (tie it all together): We've gone from the microscopic level of electrons to the massive systems that power our vehicles and shops.

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Knowledge Check

Which of the following is a renewable source of electricity?

A. Natural gas

B. Coal

C. Wind

D. Nuclear

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Knowledge Check

Why is electricity often generated in one locations but used many miles away?

A. Electricity is safer when used far from where it's generated

B. Electricity can only be used where it is produced

C. Renewable energy cannot be generated locally

D. Large generators are more efficient than small, local ones

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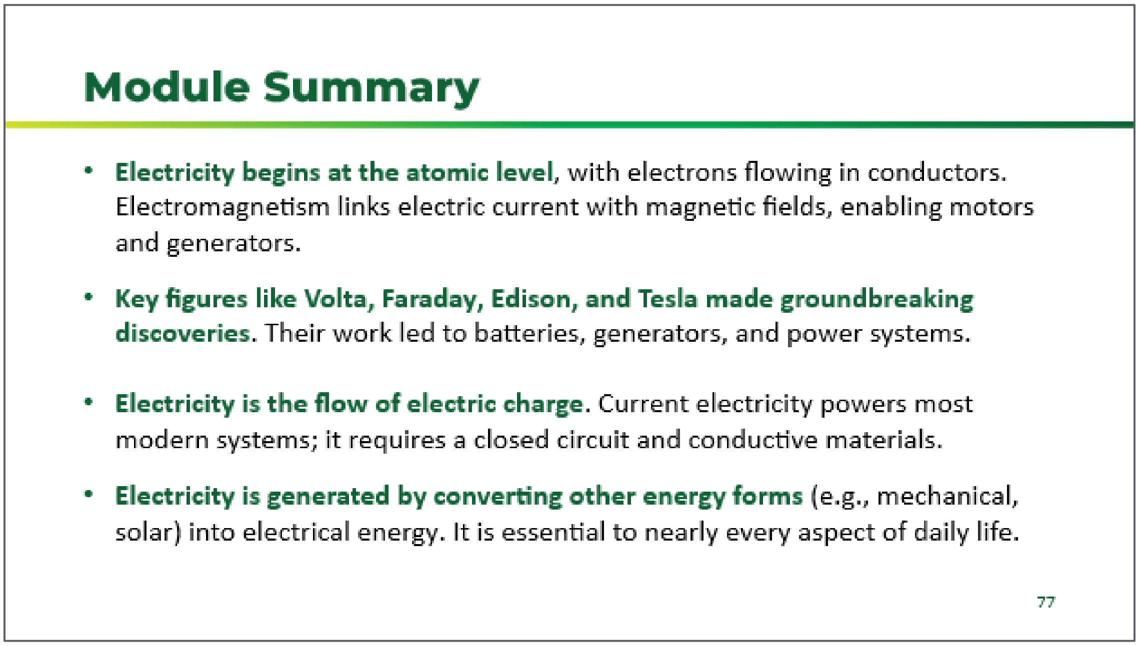
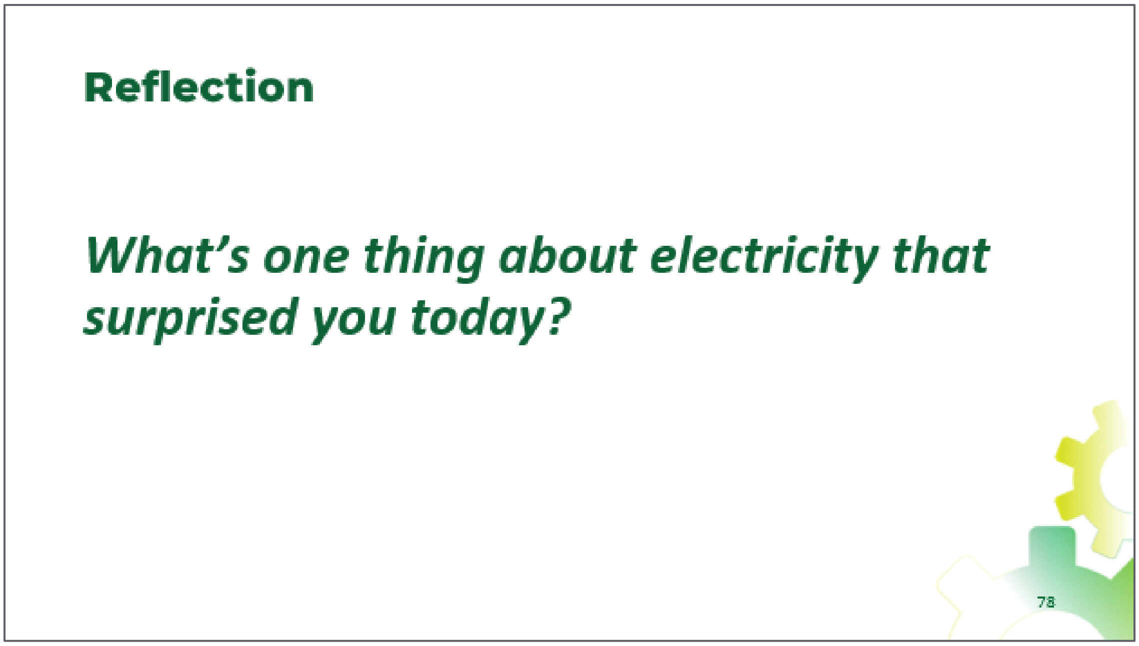


Notes:

- These four areas build a complete picture—from what electricity is, to how it's made, who developed it, and how it works on a atomic level.
- By connecting history, science, and real-world use, we've built a foundation for both understanding and applying electrical concepts.
- Let's review the key concepts from this module:
    - At its core, electricity starts with **electrons moving through atoms**. These tiny particles are responsible for creating **current** in a wire.
    - Through **electromagnetism**, we learned how electric current produces magnetic fields, and how changing magnetic fields can generate electricity—a principle that powers motors, transformers, and generators.
    - **Pioneers** like **Volta**, **Faraday**, **Edison**, and **Tesla** made major breakthroughs—creating the first batteries, generators, and power distribution systems that we still depend on today.
    - **Electricity** is the **flow of electric charge**, and in most modern systems, we rely on current electricity, which needs a closed circuit and conductive materials to function.
    - It's **generated** by converting other forms of energy—like mechanical motion, sunlight, or chemical reactions—into electrical energy. This process powers everything from homes and hospitals to trains and communication systems.


Reflection
What's one thing about electricity that surprised you today?
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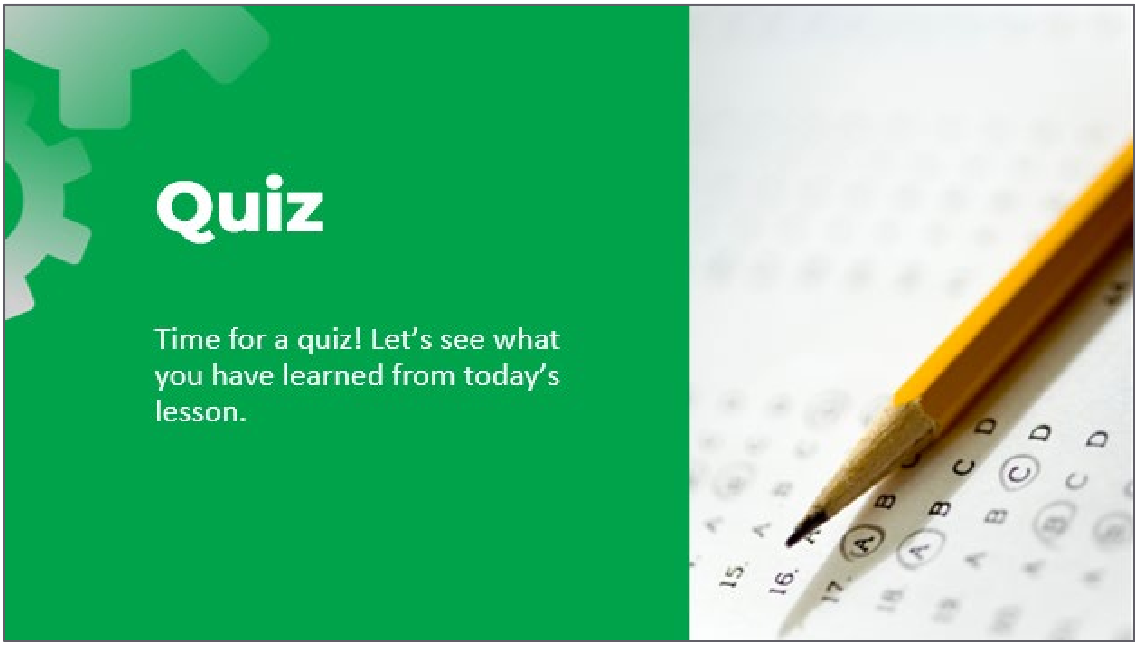
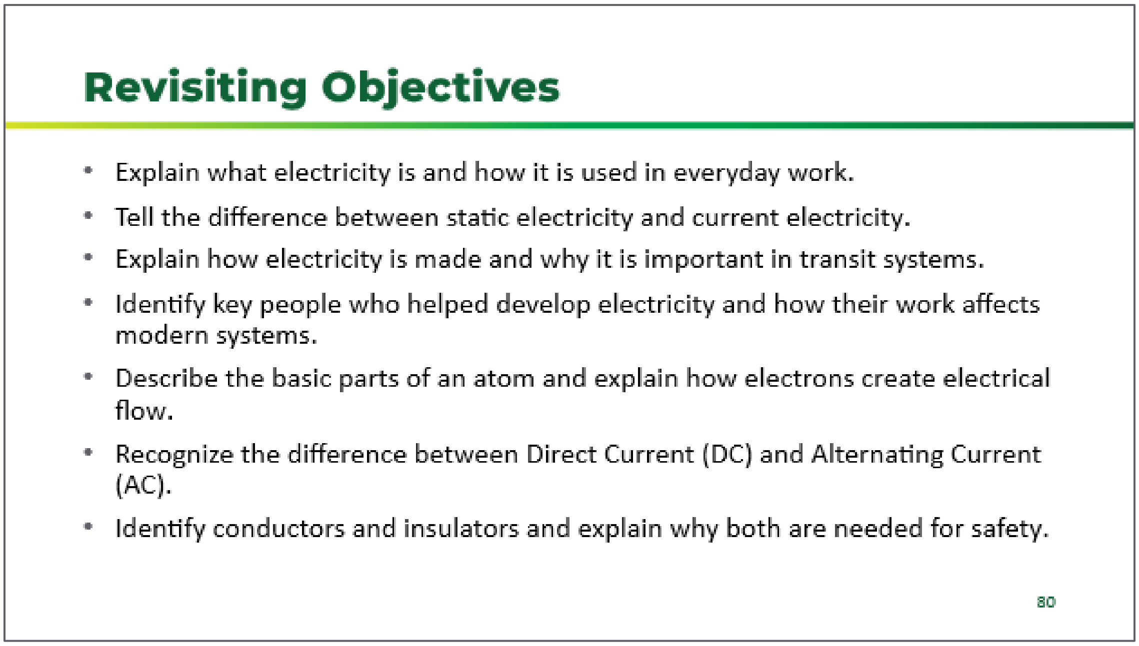

Quiz
Time for a quiz! Let’s see what you have learned from today’s lesson.



Notes:

- If you were explaining today's objectives to someone else, how would you summarize what they mean and why they matter?
- Which of today's objectives do you feel most confident about? Which were most challenging?
    - Explain your reasoning.
- Can you give an example of how you could apply one of today's objectives in a real-world situation?