**NGSS Middle School Standards for the Harley-Davidson Electrical Circuits Kit**

The Harley-Davidson Electrical Circuits Kit introduces middle school students to electricity, circuit design, measurement tools, and engineering processes. It aligns with NGSS standards in Physical Science (PS) and Engineering Design (ETS).

**NGSS Middle School Standards Covered**

**Physical Science (PS) – Energy and Electricity**

**MS-PS2-3:** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.  
**Connection:** Students explore how different materials (conductors and insulators) affect current flow, and how circuit design (series vs. parallel) changes performance.

**MS-PS3-2:** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored.  
**Connection:** Students investigate how batteries store energy and release it into electrical circuits to power LEDs and buzzers.

**MS-PS3-5:** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.  
**Connection:** Students demonstrate how energy is transferred in a functioning circuit, such as lighting an LED or activating a buzzer.

**Engineering, Technology, and Applications of Science (ETS)**

**MS-ETS1-1:** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution.  
**Connection:** Students identify electrical needs (e.g., brightness, number of components) and design circuits to meet those requirements.

**MS-ETS1-2:** Evaluate competing design solutions using a systematic process to determine how well they meet criteria and constraints.  
**Connection:** Students compare series and parallel circuits to determine which is more reliable and efficient.

**MS-ETS1-3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each.  
**Connection:** Using multimeters, students measure voltage and resistance to refine and improve circuit designs.

**MS-ETS1-4:** Develop a model for iterative testing and modification of a proposed object, tool, or process to optimize performance.  
**Connection:** Students troubleshoot and refine their circuits, making multiple modifications to improve performance.

**Key Concepts Covered in Middle School**

✔ Electrical Current & Resistance: Understanding how electricity flows and what influences resistance.  
✔ Series vs. Parallel Circuits: Testing both configurations for performance and reliability.  
✔ Energy Storage & Transfer: Using batteries to power LEDs and observe energy transformation.  
✔ Measurement Tools: Using multimeters to gather data and support redesign.  
✔ Engineering Process: Applying problem-solving, iteration, and optimization techniques.

**NGSS High School Standards for the Harley-Davidson Electrical Circuits Kit**

This kit introduces high school students to advanced circuit design, electrical measurement, and the real-world skills used in the electrical trades. It aligns with NGSS standards in Physical Science (PS) and Engineering Design (ETS).

**NGSS High School Standards Covered**

**Physical Science (PS) – Energy and Electricity**

**HS-PS3-1:** Create a computational model to calculate the change in the energy of one component in a system.  
**Connection:** Students apply Ohm’s Law (V=IR) to calculate resistance and current, modeling energy transfer across a circuit.

**HS-PS3-3:** Design, build, and refine a device that works within given constraints to convert one form of energy into another.  
**Connection:** Students build circuits that convert chemical energy (batteries) into electrical energy to power components like LEDs or buzzers.

**HS-PS3-5:** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces and energy changes.  
**Connection:** Students explore how changes in circuit materials or layouts influence current flow and energy behavior.

**Engineering, Technology, and Applications of Science (ETS)**

**HS-ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions.  
**Connection:** Students relate efficient circuit design to real-world electrical systems in homes and industries.

**HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, manageable problems.  
**Connection:** Students identify design needs like power supply, load, and safety, and develop solutions accordingly.

**HS-ETS1-3:** Evaluate a solution to a complex problem based on prioritized criteria and trade-offs (cost, safety, reliability).  
**Connection:** Students select optimal designs based on performance data, component behavior, and efficiency.

**Key Concepts Covered in High School**

✔ Circuit Behavior & Design: Building complex systems with multiple electrical loads.  
✔ Ohm’s Law & Energy Calculations: Predicting voltage, current, and resistance in various circuit types.  
✔ Multimeter Use & Data Analysis: Gathering data to diagnose issues and optimize circuits.  
✔ Engineering for Reliability: Designing safe, efficient, and functional systems.  
✔ Career Connections: Exploring roles of electricians and electrical engineers.

**NGSS Elementary Standards for the Harley-Davidson Electrical Circuits Kit**

Elementary students are introduced to basic concepts of energy, current flow, and electrical components. The kit supports NGSS standards in Physical Science (PS) and Engineering Design (ETS).

NGSS Circuits (Harley Davidson)

**NGSS Elementary Standards Covered**

**Physical Science (PS) – Energy and Electricity**

**4-PS3-2:** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.  
**Connection:** Students observe LEDs and buzzers in circuits to see how electrical energy is transferred and transformed.

**4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.  
**Connection:** Students create simple circuits that convert energy from batteries into light and sound.

**Engineering, Technology, and Applications of Science (ETS)**

**3-5-ETS1-1:** Define a simple design problem reflecting a need or want that includes specified criteria and constraints.  
**Connection:** Students plan their circuits with constraints such as materials and desired output (e.g., lighting multiple LEDs).

**3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem.  
**Connection:** Students experiment with different circuit configurations and choose the most effective one.

**Key Concepts Covered in Elementary School**

✔ Energy Transfer: Observing how batteries power LEDs and buzzers.  
✔ Circuit Basics: Identifying parts like wires, switches, and batteries.  
✔ Design Thinking: Planning and building circuits that work reliably.  
✔ Testing & Redesign: Making improvements based on results and observations.  
✔ Hands-On Discovery: Encouraging curiosity about how electricity works.