## 📍 Station 3: Circuit Layout Garage – Series vs. Parallel Design

**NGSS: HS-PS3-5** – Model how layout affects energy and force in a circuit

### 🎯 Goal: Build and compare series vs. parallel circuits.

**Materials:**

* Breadboard or cardboard
* 2-3 LEDs
* Battery + holder
* Jumper wires
* Switch
* Resistors

### 🛠️ Student Directions:

🔄 **Step 1: Build a Series Circuit**

1. Connect LEDs in a single path with resistors.
2. Test brightness and functionality.

🔄 **Step 2: Build a Parallel Circuit**

1. Wire each LED on its own branch to the power source.
2. Observe and record differences.

📓 **Compare:**

| **Configuration** | **LED Brightness** | **What Happens If 1 LED Fails?** |
| --- | --- | --- |
| Series |  |  |
| Parallel |  |  |

### 💬 Reflection Prompts:

1. Which layout is more energy-efficient? Why?  
   → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. How do real homes use parallel circuits for safety and efficiency?  
   → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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### ✅ **ITEEA STEL Standards – High School**

**STEL 1E** – Technological systems use energy, information, and resources to achieve goals.  
→ Students explore how **circuit configuration** affects how energy flows and how the system performs.

**STEL 2E** – Technological decisions should consider efficiency, safety, and sustainability.  
→ Students analyze the **efficiency and reliability** of series vs. parallel layouts, mirroring real-world electrical system decisions.

**STEL 3E** – Systems thinking involves understanding how parts interact within a system.  
→ Students examine how removing or modifying one LED affects the entire system depending on the circuit type.

**STEL 4E** – Troubleshooting and problem-solving help identify failures and improve designs.  
→ Students detect which circuit performs better under failure conditions (e.g., one LED breaking) and adjust layouts accordingly.

**STEL 5E** – Engineering design involves testing and refining solutions.  
→ The activity involves designing two different circuits, **comparing their performance**, and deciding which is more effective.

**STEL 6E** – Modeling and prototyping represent technology solutions.  
→ Students create physical models to represent the differences in energy behavior between **series** and **parallel** circuits.

**STEL 7E** – Design constraints affect outcomes.  
→ Considerations such as voltage, brightness, and circuit continuity under failure reflect real-world design trade-offs in systems engineering.

### ✅ **Common Core Math Standards – High School**

**CCSS.MATH.CONTENT.HSN.Q.A.1–3** – Use appropriate quantities and units in describing circuits (voltage, current, resistance).  
→ Students describe behavior using correct electrical units and interpret data like brightness levels.

**CCSS.MATH.CONTENT.HSA.CED.A.1** – Create equations to represent circuit behavior (V = IR in different branches).  
→ Students relate resistance and voltage in **series vs. parallel circuits** through calculations or qualitative comparison.

**CCSS.MATH.CONTENT.HSA.REI.B.3** – Solve equations and inequalities to understand current distribution in circuits.  
→ Students predict how current splits or accumulates and validate their predictions by building circuits.

**CCSS.MATH.PRACTICE.MP2** – Reason abstractly and quantitatively.  
→ Students compare numerical outcomes (brightness, LED failure effects) across both configurations.

**CCSS.MATH.PRACTICE.MP4** – Model with mathematics.  
→ Students apply **Ohm’s Law** and series/parallel rules to understand how the system’s total resistance affects performance.

**CCSS.MATH.PRACTICE.MP5** – Use appropriate tools strategically.  
→ Students use multimeters, breadboards, and wires to **build and test real-world models** of energy systems.

### ✅ Summary

This activity integrates **NGSS physical science modeling**, **ITEEA systems thinking and troubleshooting**, and **Common Core mathematical modeling** by guiding students through **hands-on exploration** of **series and parallel circuit design**—just like engineers do in household and automotive systems.

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