**⚡ Station 2: “The Power Puzzle”**

**NGSS Connection:** *HS-PS3-1 (Energy conservation), HS-PS3-2 (Energy transfer in circuits)*
**Class: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Partner(s): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**🎯 Your Mission:**

You’re the circuit designer for a high-tech LED lighting system! Your job is to figure out the **correct resistance** needed to safely power your LED—too much current, and it could burn out!

**FOCUS:**

Energy Transfer, Resistance, and Current Control in Electrical Circuits

**🛠️ Materials at This Station:**

* Copper foil or wire strips (short and long pieces)
* LED light
* Battery (e.g., coin cell or 9V)
* Multimeter (to measure voltage or current)
* Optional: Resistors of various values
* Tape and scissors

**Student Directions:**

**STEP 1: Build a Simple LED Circuit**

* Connect your LED to the battery using **short copper tape strips** or wires first.
* Observe the **brightness** of the LED. Is it too bright? Dim? Just right?

**STEP 2: Try a Longer Copper Tape Path**

* Replace one of the short strips with a **longer path** of copper tape.
* Observe again: Has the brightness changed?

**STEP 3: Estimate or Measure Values**

* Use the **multimeter** to measure:
	+ **Voltage (V)** across the LED
	+ **Current (I)** flowing in the circuit
	*OR* use the LED packaging to estimate how much voltage/current it needs (most LEDs use ~2V and 20mA).

 **Calculate Resistance**

* Use **Ohm’s Law**:
* Use your measurements or estimates to solve for **R** (resistance needed in ohms, Ω).

**Data Recording Table:**

| **Setup Type** | **Voltage (V)** | **Current (A)** | **Resistance (Ω)** | **LED Brightness (Low / Medium / High)** |
| --- | --- | --- | --- | --- |
| Short copper strip |  |  |  |  |
| Long copper strip |  |  |  |  |
| (Optional) with resistor |  |  |  |  |

**🔍 Analysis & Challenge:**

* **Voltage used:** \_\_\_\_\_\_\_\_\_\_\_
* **Resistance calculated:** \_\_\_\_\_\_\_\_\_\_\_
* **What happened when resistance was too low?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**💬 Discussion Prompts:**

* How does resistance affect how much energy your LED receives?
* What might happen to a real-world device if resistance isn’t controlled properly?
* Why do you think engineers carefully calculate resistance in every circuit?

⚡ **Station 2: “The Power Puzzle”**
🔬 **NGSS Connection:**
**HS-PS3-1** – Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and the energy flows in and out of the system are known.
**HS-PS3-2** – Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles and energy associated with the relative position of particles.

✅ **ITEEA STEL Standards – High School**

**STEL 1H** – Technological systems include input, processes, output, and feedback.
→ Students build and modify a circuit system, observe outcomes, and use feedback to adjust resistance.

**STEL 4J** – The engineering design process involves defining the problem, generating ideas, selecting solutions, testing, and evaluating.
→ Learners test multiple circuit configurations and evaluate LED brightness to solve a design challenge.

**STEL 5F** – Data is analyzed to refine technological systems.
→ Students collect voltage and current data to improve circuit efficiency.

**STEL 7G** – Mathematics is used to model and analyze technological systems.
→ Ohm’s Law and measurement data are used to calculate resistance values.

**STEL 8H** – Applying science, math, and engineering principles helps solve practical problems.
→ Learners apply physics and electrical formulas to solve real-world issues in circuit design.

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

**HSN-Q.A.1** – Use units as a way to understand problems and guide the solution of multi-step problems.
→ Students measure voltage and current, using correct units in calculations.

**HSN-Q.A.2** – Define appropriate quantities for the purpose of descriptive modeling.
→ Voltage, current, and resistance are defined and applied to solve problems.

**HSN-Q.A.3** – Choose a level of accuracy appropriate to limitations on measurement.
→ Students interpret multimeter readings and account for accuracy in analysis.

**HSF-IF.C.7** – Graph functions expressed symbolically and show key features.
→ (Extension) Students could graph voltage vs. resistance or brightness vs. current.

**HSA-CED.A.4** – Rearrange formulas to highlight a quantity of interest.
→ Students manipulate Ohm’s Law to solve for resistance R=VIR = \frac{V}{I}R=IV​.

💡 **Summary:**
This activity strengthens cross-disciplinary skills by combining physical science (energy transfer), engineering (circuit construction), math (modeling with Ohm’s Law), and data literacy. It supports systems thinking, problem-solving, and the interpretation of quantitative data within the context of real-world technology.