**🔥 Station 3: Hot Circuits!**

**NGSS Standard:** *MS-PS3-3 – Apply scientific principles to design devices that convert energy.*
**Focus Question:** *What happens when circuits resist electric current?*

**Your Mission:**

You’ll explore how **resistance** affects electrical energy. Some resistors slow down current more than others. As electricity encounters resistance, energy can turn into **heat**—just like in real devices!

**FOCUS:**

Energy Conversion in Circuits – How Electrical Resistance Affects Heat and Light Output

**Materials at Your Station:**

* Battery pack (3V–9V)
* LED (with built-in or external resistor)
* Three resistors: 100Ω (low), 330Ω (medium), 1kΩ (high)
* Alligator clip wires or breadboard
* Infrared thermometer or use fingers to carefully sense warmth (ask your teacher first!)
* Stopwatch (optional, for timed tests)

**Student Directions:**

 **STEP 1: Set Up Your Circuit**

* Use the **battery**, **LED**, and **resistor** to create a simple series circuit.
* Start with the **100Ω resistor**.
* Make sure your LED lights up—**long leg = + (positive side).**
* Observe the **brightness** and carefully (or using the thermometer) check for **heat near the resistor** after it’s been on for 20–30 seconds.

**STEP 2: Repeat the Test**

* Switch out the 100Ω resistor with the **330Ω resistor**.
* Repeat the observation: brightness and any heat.
* Then test the **1kΩ resistor** (1,000 ohms).
* Wait the same amount of time for each test before checking for heat or brightness.

**STEP 3: Fill in the Data Table:**

| **Resistor Value** | **Brightness** | **Heat Observed? (Yes/No)** |
| --- | --- | --- |
| 100Ω | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ☐ Yes ☐ No |
| 330Ω | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ☐ Yes ☐ No |
| 1kΩ | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ☐ Yes ☐ No |

 **Think & Record:**

**What did you learn about resistance and energy in circuits?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Which resistor let the most current flow? How could you tell?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**In a real-world device, why might we want higher or lower resistance?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Station 3: “Hot Circuits!”** activity:

🔥 **NGSS Standard:**
**MS-PS3-3** – *Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*

✅ **ITEEA STEL Standards – Middle School**

**STEL 1E** – Technological systems use inputs, processes, outputs, and feedback to solve problems.
→ Students design and test different circuit configurations to observe energy output (light/heat) based on resistor choice.

**STEL 4E** – Testing and evaluation are used to refine technological designs.
→ Students evaluate three resistor values to determine which best regulates current and energy output, simulating a design refinement process.

**STEL 6F** – Energy is the capacity to do work.
→ This activity shows how energy is transformed within a circuit and emphasizes the concept of resistance converting electrical energy into thermal energy.

**STEL 8E** – Devices can be designed to control and modify energy.
→ Students see firsthand how a resistor controls the amount of current flowing and how that control modifies the energy output of the circuit.

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

**CCSS.MATH.CONTENT.6.SP.B.4** – Display numerical data in plots, such as tables.
→ Students organize brightness and heat results in a data table and look for patterns across trials.

**CCSS.MATH.CONTENT.7.RP.A.2A** – Recognize and represent proportional relationships between quantities.
→ Students can compare how increasing resistance decreases brightness, reinforcing a proportional relationship.

**CCSS.MATH.CONTENT.7.EE.B.4** – Use variables to represent quantities in a real-world problem and solve problems using equations.
→ Students may use Ohm’s Law (V = IR) if extended, or compare energy outcomes quantitatively with variables and reasoning.

💡 **Summary:**
This activity allows students to explore energy conversion and resistance in a hands-on, experimental way. It integrates science, math, and engineering design by guiding them through structured testing, analysis, and discussion of how resistance controls current and heat in real-world circuits.