## UNIT: MEASUREMENT

# "POWER THE ARM" – VOLTAGE & ENERGY TRANSFER

**OBJECTIVE:**

Use a multimeter to measure voltage in a circuit designed to "power" a part of the rover.

**GOAL:**

You will build a simple LED circuit, use a multimeter to measure energy flow (voltage), and engineer a modification that lets the LED turn on only when a condition is met—just like powering a robotic arm on a rover!

**MATERIALS:**

- ✓ Coin battery (CR2032 or similar)
- ✓ LED light
- ✓ Alligator clips or wire leads
- ✓ Paperclip (for a manual switch)
- ✓ Multimeter (with voltage and continuity modes)
- ✓ Optional: Resistor, tilt switch, or pressure sensor

**STUDENT DIRECTIONS:**

**Step 1: Build a Basic Circuit**

1. Connect the **positive (+)** side of the coin battery to the **long leg (anode)** of the LED using wire or clips.
2. Connect the **short leg (cathode)** of the LED to the **negative (-)** side of the battery to complete the circuit.
3. Insert a **paperclip** between the circuit as a simple switch—pressing it completes the connection.

**Tip:** If the LED doesn't light, check your connections or reverse the LED legs.

**Step 2: Use the Multimeter**

1. **Measure Voltage Across the LED**
   - Set your multimeter to DC voltage (V⎓).
   - Place the red probe on the positive LED leg and black on the negative.
   - Record the voltage:
     - Voltage across LED: _____ V
2. **Test Continuity of the Wires**
   - Switch your multimeter to continuity mode ( 🔔 symbol).
   - Touch both probes to each end of a wire.
   - If it beeps, the wire conducts electricity well.
3. **(Optional) Measure Resistance of Components**
   - Set your multimeter to $\Omega$ (ohms).
   - Test any resistors or other parts (like a pressure switch).
   - Record the resistance value.

**Step 3: Engineering Challenge – Conditional Power**

**Your goal:** Modify your circuit so the LED turns on only when the "arm" moves or when a specific condition is met.

Choose one idea:
- Use a **tilt sensor** or a hanging paperclip that shifts when tilted
- Use a **pressure switch** (e.g., foil layers that connect only when pressed)
- Use your **paperclip switch** to close when a part of the rover moves

**Sketch or describe your design**

- My design idea: _____

**Reflection Questions:**

- How does energy transfer from the battery to the LED in your circuit?

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- What happened when you changed the materials or added a switch?

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- Why might a real robotic arm need conditional circuits like this?

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**STANDARDS ALIGNMENT**

**NGSS:** HS-PS3-3 **STEL:** STEL 1E, STEL 2E, STEL 7F, STEL 8F, STEL 11F **CCSS:** CCSS.MATH.CONTENT.HSN.Q.A.1, CCSS.MATH.CONTENT.HSN.Q.A.3, CCSS.MATH.CONTENT.HSA.CED.A.2, CCSS.MATH.PRACTICE.MP4, CCSS.MATH.PRACTICE.MP5