**NGSS HS Activity for Measurement Kit**

**📏⚙️ Activity Title: “Mission Measure: Rescue the Rover!”**

**A Precision Measurement + Physics Engineering Challenge**

**Grade Level:** High School
**Time:** 1–2 class periods
**NGSS Standards Aligned:**

* HS-PS1-3
* HS-PS2-1
* HS-PS3-3
* HS-PS3-5

**🧭 Student Scenario:**

🚀 A research rover on Mars has a damaged robotic arm. Your team of engineers must **measure**, **repair**, and **recalibrate** its components using only simple tools found in your emergency STEM kit. Your goal: restore movement, test current flow, and calculate motion and energy conversion—**with precision.**

**🛠️ Materials (Simple & Accessible):**

* Rulers (metric + imperial)
* Digital or analog calipers
* Multimeter (for continuity, voltage, resistance)
* Springs (from pens or toys)
* Rubber bands
* Washers or coins (as weights/mass)
* Cardboard, paperclips, tape
* Toy car or homemade rover base (optional)
* Ramp (folded cardboard works!)
* Stopwatch (or phone timer)
* String and pulley/spool (optional)
* Wire and LED (for circuit testing)
* Magnets (optional for extension)

**🔧 Activity Stations:**

**🔍 Station 1: “Broken Arm Blueprint”**

**Standard:** HS-PS1-3
**Objective:** Use **precision measurement** tools to measure and compare the physical properties of “replacement parts.”

**Goal:**

You're acting as a **biomedical engineer** helping to design a replacement rod for a broken arm. Your job is to **measure and test** different sample materials and decide which one is the best match for the “reference bone.”

**Materials Needed:**

* Calipers or ruler (for measuring diameter/thickness)
* Samples of rod-like materials (pencil, plastic straw, paper straw, wooden dowel, etc.)
* Digital scale or balance (for weight comparison)
* Optional: Spring + weights (to test compression)
* “Reference part” (plastic bone or wooden dowel marked as the ideal)
* Data recording sheet

 **Student Directions:**

**Measure Size**

* Use the **calipers or ruler** to measure the **diameter and length** of each sample rod.
* Compare those measurements to the reference part.
* Record all your data in a chart.

**Data Example Table:**

| **Sample** | **Diameter (mm)** | **Length (cm)** | **Matches Reference? (Yes/No)** |
| --- | --- | --- | --- |
| Pencil |  |  |  |
| Dowel |  |  |  |

**2. Compare Strength (Qualitative Test)**

* Pick up each sample and gently press it down over a table edge to **feel stiffness** (Does it bend? How much?).
* Optional: Stack small weights on top or use a spring compression setup to test how much each sample resists force.
* Observe and record which ones **stay straight, bend, or collapse**.

**3. Check Weight or Density**

* Use a **digital scale** to find the mass of each sample.
* Consider how the **weight might affect comfort and usability** if it were inside a human arm.

**Density Tip:** A heavier but smaller part may be **denser**, meaning its material is more compact and possibly stronger.

**4. Choose the Best Match**

* Based on your data, pick the material that is **closest in size, strength, and weight** to the reference part.

**💬 Discussion Prompt:**

* **How does the bulk structure (the way the material is built or packed) affect its strength and function?**
→ Think about bones—are they solid or hollow? Why?
→ Why might we **not always want** the heaviest or hardest material?
* How does the bulk structure of a material relate to its strength or function?

 **Station 2: “Force Finder” – Newton’s Second Law Lab**

**Standard:** HS-PS2-1
**Objective:** Measure mass and acceleration to apply **F = ma**.

**Goal:**

You’re testing how the **mass of a moving object (a mini rover)** and its **acceleration** are related to the **net force** acting on it. You’ll roll a rover down a ramp, **measure time and distance**, and calculate acceleration and force using physics formulas.

 **Student Directions:**

**Materials Needed:**

* Ramp (books + board or foam ramp)
* Small “rover” (toy car or weighted container with wheels)
* Stopwatch
* Ruler or measuring tape
* Washers or coins (for adding mass)
* Calculator
* Data sheet or notebook

**Student Directions:**

**Step 1: Set Up the Ramp**

* Place your ramp on a stable surface. Measure the **length of the ramp** (distance the rover will travel from top to bottom).
📏 Record distance (d): \_\_\_\_\_\_\_ cm or meters

**Step 2: Test with Starting Mass**

* Put your rover at the top of the ramp.
* Get ready with your **stopwatch**.
* Let it go and **time how long it takes** to reach the bottom.
⏱ Record time (t): \_\_\_\_\_\_\_ seconds

**Step 3: Repeat with More Mass**

* Add 1–2 washers or coins to your rover to increase mass.
* Repeat the test. Do this **at least 3 times** with different masses.
* Each time, record the time it takes and keep the ramp angle the same.

**Step 4: Calculate Acceleration**

Use the formula:

Where:

* aaa = acceleration
* ddd = distance traveled down the ramp
* ttt = time measured

💡 Use a calculator and show your work!

**Step 5: Calculate Force**

Next, use the formula:

Where:

* FFF = Force
* mmm = Mass of rover (use total mass including added washers—estimate in kg if possible)
* aaa = Acceleration from the last step

📝 Record in a chart:

| **Trial** | **Mass (kg)** | **Time (s)** | **Acceleration (m/s²)** | **Force (N)** |
| --- | --- | --- | --- | --- |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

**💬 Discussion Prompts:**

* What happened to the **acceleration** when the mass increased?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Did the **net force** increase or stay the same? Why do you think that happened?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How did using a **stopwatch or measuring tools** help improve the accuracy of your calculations?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**⚡ Station 3: “Power the Arm” – Voltage & Energy Transfer**

**Standard:** HS-PS3-3
**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 Needed:**

* 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

1. **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.
2. **(Optional) Measure Resistance of Components**
	* Set your multimeter to Ω (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?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* What happened when you changed the materials or added a switch?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Why might a real robotic arm need conditional circuits like this?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

turns on only when the “arm” reaches a certain position (e.g., tilt or pressure sensor).

**🧲 Station 4: “Field Forces” – Electromagnetic Arm Assist**

**Standard:** HS-PS3-5
**Objective:** Investigate how **electric or magnetic fields** interact with objects.

**Goal:**

You will **build a simple electromagnet**, explore how well it can lift or move magnetic objects, and **measure its electrical properties** using a multimeter. Then, you’ll reflect on how electromagnets could help move parts in a robotic arm.

**Materials Needed:**

* Iron nail (3–4 inches)
* Insulated copper wire (about 3 feet)
* AA battery (or 9V battery for stronger field)
* Electrical tape or alligator clips
* Paperclips, small metal objects
* Compass (optional)
* Multimeter (for voltage and resistance)

📝 **Student Directions:**

**Step 1: Build Your Electromagnet**

1. **Wrap the Wire**
	* Tightly coil the wire around the nail, leaving about 3 inches of wire free on each end.
	* Try to make the coils neat and close together (this increases the strength).
2. **Connect to Power**
	* Tape one wire end to the positive (+) terminal of the battery.
	* Quickly touch and hold the other wire end to the negative (–) terminal.
	* ⚠️ **Only connect for short intervals (10–15 seconds)** to prevent the wire from overheating!
3. **Test It**
	* Try to pick up paperclips or attract small metal objects.
	* Move a compass near your electromagnet—does the needle react?

**Step 2: Measure the Electromagnetic Properties**

1. **Voltage Across Your Coil**
	* Set your multimeter to DC Voltage (V⎓).
	* Connect probes to both wire ends *while connected to the battery*.
	* Record the voltage:

🔋 Coil Voltage: \_\_\_\_\_\_\_\_\_\_\_ V

1. **Resistance of the Coil**
	* Disconnect the battery.
	* Set the multimeter to resistance (Ω).
	* Connect probes to each wire end of the coil.
	* Record resistance:

🔌 Coil Resistance: \_\_\_\_\_\_\_\_\_\_\_ Ω

**🧠 Engineering Reflection**

💭 What variables seemed to make your electromagnet stronger?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

💭 How could a robotic arm use this kind of electromagnetic system to pick things up?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

💭 What might limit how strong your electromagnet can be?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🔬 Extension Challenge (Optional)**

Can you increase the strength of your magnet by:

* Adding more coils?
* Using a larger nail?
* Using more batteries?

Test and compare results—record your changes and findings below.

**🧠 Final Challenge: Build & Test the Arm**

**Goal:** Use what you’ve learned from the other stations to **design, build, and test a functional arm or ramp system** that can move, measure, and signal success—just like a real prosthetic or rover tool.

**Challenge Overview:**

Use the **best materials or designs** from each station to build a mechanical **arm, grabber, or launcher system** that:

✅ **Moves** (using elastic bands, springs, or magnets)
✅ **Measures** something (like distance, angle, or height)
✅ **Signals** when the task is complete (with an LED or buzzer)

**Materials needed:**

* Rubber bands, springs, dowels, straws, craft sticks
* Paperclips, magnets, aluminum foil
* LED light, buzzer, coin battery
* Ruler, protractor (for measuring distance or angle)
* Cardboard, scissors, tape, string, paper towel tubes
* Multimeter (optional for testing current or voltage)

**Student Directions:**

**🔹 Step 1: Plan Your Design**

Before building, sketch or write out your idea:

* **What will your arm or ramp do?** (grab, push, launch, lift, etc.)
* **How will it move?** (rubber band, magnet, spring)
* **How will it measure something?** (ruler, angle, stretch length)
* **How will you signal success?** (LED lights up, buzzer sounds)

📐 Use this space to draw your blueprint or describe your idea:

✏️ Sketch / Notes:

**🔹 Step 2: Build Your System**

* Start with the **main structure** (ramp, base, arm, etc.).
* Add your **motion system** (rubber band, magnet, etc.).
* Attach any **measurement tools** (ruler for distance, protractor for angle).
* Connect a **simple circuit** to trigger your **signal** (LED or buzzer).

⚠️ Be safe when using batteries or scissors. Ask for help if needed!

**🔹 Step 3: Test & Improve**

* Try your build at least **3 times**.
* Does it work every time?
* Make changes if needed. Engineers test and improve constantly!

✅ Did your arm or ramp:

* Move with energy from a spring, magnet, or elastic?
* Measure something accurately?
* Light up or signal success?

**📊 Final Reflection & Team Check-In**

1. **What worked best in your design?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. **What was hardest to figure out?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. **How did your knowledge of energy, materials, and circuits help?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. **If you had one more hour, what would you upgrade?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**✅ Wrap-Up Prompts (Student Reflection):**

* How did precision measurement help in choosing the best materials?
* What was the most challenging part of working with small forces or currents?
* How do you see measurement and energy transfer working together in real-world tech?

**📌 NGSS Learning Summary:**

| **Standard** | **Activity Connection** |
| --- | --- |
| **HS-PS1-3** | Material structure + caliper use |
| **HS-PS2-1** | Newton’s Second Law with motion + mass |
| **HS-PS3-3** | Circuit design + energy transfer |
| **HS-PS3-5** | Electromagnetic interaction |

Top of Form

**NGSS MIDDLE SCHOOL**

**🧪 Measurement Matters! – Exploring Forces, Energy, and Materials**

**Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    **Date:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
**Class/Group:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   **Partner(s):** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🎯 **Your Mission:**
You are a Measurement Detective! Your job is to use real scientific tools to investigate how size, mass, voltage, and energy affect motion and materials. Rotate through each station, follow the instructions, and record your observations.

**📍 Station 1: Ruler Runway**

**Focus:** Measuring Distance, Speed & Kinetic Energy
**NGSS:** MS-PS3-1, MS-PS3-5, 2-PS1-1

**Goal:**

Investigate how the **height of a ramp** affects the **speed** and **distance** of a moving object (toy car or marble). Learn how height, speed, and kinetic energy are connected!

### **Materials Needed:**

* Ramp (build with a binder, clipboard, or stack of books)
* Toy car or marble
* Ruler or measuring tape
* Stopwatch or timer (a phone works)
* Notebook or worksheet to record your data

**Student Directions:**

#### tep 1: Build Your Ramp

1. Use 1 book to start. Lay a ruler, clipboard, or flat board on top to make a ramp.
2. Place the **bottom of the ramp on the floor** and the top on the book stack.

#### 🔹 Step 2: Test Run

1. Place the toy car or marble at the top of the ramp.
2. **Let it go—don’t push it!** Start your timer as it begins to move.
3. Stop the timer when the car reaches the bottom of the ramp.

#### 🔹 Step 3: Measure

1. Use the ruler to measure how far the car or marble travels after it leaves the ramp (distance).
2. Record how long it took (time).
3. Repeat the run **2 times for each ramp height** to get an average.

#### 🔹 Step 4: Change Ramp Height

1. Add one more book under the ramp. Repeat the test steps above.
2. Do the same again with 3 books.

### 📊 What to Record:

Use a table like this in your notebook:

| **Ramp Height (Books)** |  **Distance Traveled (cm)** | **Time (s)** | **Speed = Distance ÷ Time (cm/s)** |
| --- | --- | --- | --- |
| 1 Book |  |  |  |
| 2 Books |  |  |  |
| 3 Books |  |  |  |

### 💬 Reflection & Discussion:

1. **What happened to the distance and speed as the ramp got taller?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. **What does this tell you about energy and motion?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. **If we used a heavier object, what might happen? Why?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**What to Record:**

* Ramp Height: \_\_\_\_\_\_\_\_
* Distance Traveled: \_\_\_\_\_\_\_\_
* Time Taken: \_\_\_\_\_\_\_\_
* Speed (Distance ÷ Time): \_\_\_\_\_\_\_\_

📝 **What did you notice when the ramp got taller?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 2: Energy Explorer**

**Focus:** Measuring Voltage and Energy Transfer
**NGSS:** MS-PS3-5, 4-PS3-4, 3-PS2-4

### **Goal:**

Explore how electrical energy is transferred from a battery to a device, like a motor or LED, and how voltage relates to how much energy is being delivered.

**Materials Needed:**
 1 AA battery

 Multimeter

 Small motor or LED light

 Alligator clip wires (2–3)

**Student Directions:**

#### Step 1: Build Your Circuit

1. Connect one wire from the **positive (+) end of the battery** to one end of the **motor or LED**.
2. Connect another wire from the **negative (–) end of the battery** to the **other side of the motor or LED**.
3. Observe: Does the device **turn on, spin, or light up?**

#### 📏 Step 2: Measure Voltage with a Multimeter

1. Set the multimeter to **DC volts (V)**, in the 20V or 2V range.
2. Touch the black probe to the **negative (-)** battery terminal.
3. Touch the red probe to the **positive (+)** battery terminal.
4. Write down the number on the screen — that’s the **voltage**!

#### 🔁 Step 3: Reverse the Battery

1. Carefully switch the wires — connect the battery **backward**.
2. Observe what happens to the motor or LED.
	* Did it **spin the other way**?
	* Did the **light turn off or dim**?
3. Try measuring the voltage again.

### 📊 Record Your Results:

| **Test** | **Voltage Reading (V)** | **Motor/Light Reaction** | **What Happened When Reversed?** |
| --- | --- | --- | --- |
| Try 1 |  |  |  |
| Try 2 (Reversed) |  |  |  |

### 💬 Think & Reflect:

📝 **How does electrical energy change when transferred to the motor or light?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🧠 **Bonus Question:** What form of energy does the motor or light give off?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 3: Mass Matters**

**Focus:** Mass, Force & Motion
**NGSS:** MS-PS2-2, MS-PS3-1, 2-PS1-1

### **Goal**:

Test how the **mass** of an object affects how far it moves when you apply the **same force**. Learn how mass, motion, and energy are connected.

**Materials Needed:**
 Digital scale or spring scale

 3 blocks or objects of different masses

 Flat surface or ramp

 Ruler or measuring tape

 Tape (optional, for start lines)

**Student Directions:**

#### Step 1: Measure Mass

1. Use the **scale** to find the **mass (in grams)** of each object or block.
2. Label them as **Mass 1**, **Mass 2**, and **Mass 3** (lightest to heaviest).
3. Write down the mass of each.

#### 🏁 Step 2: Set Up the Test Area

1. Choose a flat surface or a small ramp.
2. Use tape to mark the **starting line** for each object.
3. Place the first object behind the line.

#### 💨 Step 3: Push and Measure

1. Gently push **Mass 1** with the **same light push** each time.
(Tip: Use just one finger or push for one second to keep it consistent.)
2. Measure how far it slides **from the start line** using a ruler.
3. Record the **distance (in cm)**.
4. Repeat for **Mass 2** and **Mass 3**, using the same force.

### 📊 Record Your Results:

| **Object** | **Mass (g)** | **Distance Moved (cm)** |
| --- | --- | --- |
| Mass 1 (Light) |  |  |
| Mass 2 (Medium) |  |  |
| Mass 3 (Heavy) |  |  |

### 💬 Think & Reflect:

📝 **How did the object’s mass affect how far it moved with the same push?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🧠 **Why do you think heavier objects don’t move as far with the same force?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 4: Material Detective**

**Focus:** Properties of Materials
**NGSS:** MS-PS1-2, 2-PS1-1

### **Goal:**

Use tools and tests to investigate **thickness**, **magnetism**, and **electrical conductivity** of different materials. Learn how physical properties help us choose the right material for a job!

**Materials needed:**
 Ruler or caliper

 Samples: metal, plastic, wood, paper (labeled or numbered)

 Magnet

 Multimeter (set to continuity or resistance mode)

**Student Directions:**

#### Step 1: Measure the Thickness

1. Use a **ruler or caliper** to measure how thick each material sample is (in **mm or cm**).
2. Record it in your chart.

#### 🧲 Step 2: Test Magnetism

1. Gently touch the **magnet** to each material sample.
2. Does the sample **stick to the magnet**?
	* Check the box: ☐ Yes or ☐ No

#### ⚡ Step 3: Test Electrical Conductivity

1. Turn the **multimeter** to continuity mode (or resistance, if instructed).
2. Touch the two probes to opposite sides of the sample.
3. Watch the screen or listen for a beep:
	* Beep or low number? ✅ It **conducts electricity**
	* No beep or high number? ❌ It **does NOT conduct**

### 📊 Record Your Findings:

| **Material** | **Thickness (cm or mm)** | **Magnetic?** | **Conducts Electricity?** |
| --- | --- | --- | --- |
| Metal |  | ☐ Yes ☐ No | ☐ Yes ☐ No |
| Plastic |  | ☐ Yes ☐ No | ☐ Yes ☐ No |
| Wood |  | ☐ Yes ☐ No | ☐ Yes ☐ No |
| Paper |  | ☐ Yes ☐ No | ☐ Yes ☐ No |

### 💬 Think & Reflect:

📝 **Which materials might be most useful in building a circuit or structure? Why?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🧠 **How does knowing the physical properties of a material help engineers?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🧠 Challenge Question (Wrap-Up):**

**Imagine you're designing a race track or a robotic arm. How would accurate measurement help you? How does energy or mass affect how it works?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bottom of Form

**NGSS ELEMENTARY SCHOOL**

**🧰 STEM 101: Measurement Explorers!**

**Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_    **Date:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
**Class/Group:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   **Partner(s):** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🎯 **Your Mission:**
Become a *Measurement Explorer!* At each station, use your tools to measure, observe, and build. You’ll test materials, play with magnets, and even light up a bulb using your scientific skills!

**📍 Station 1: Measure & Sort!**

**Focus:** Classifying by Observable Properties
**NGSS Standard:** **2-PS1-1**

### **Goal**:

You will **measure** and **compare** the lengths of everyday classroom items. Then, you'll **sort** and **analyze** the data to look for patterns and relationships between objects.

**Materials needed:**

 Ruler (with **centimeters** and **inches**)

 (Optional) Digital or plastic **caliper** for precise measuring

 Small objects: pencil, eraser, spoon, stick, crayon, cube

 Measurement Recording Chart

**Student Directions:**

#### Step 1: Measure Your Objects

1. Pick one object at a time.
2. Use your **ruler** (or caliper) to measure:
	* **Length** (the longest side)
	* **Width** (the shorter side, if needed)
3. Record both measurements in **centimeters (cm)** and **inches (in)** in your chart.
	* Measure to the **nearest tenth** (e.g., 5.2 cm or 2.1 in)
	* Ask your teacher for help if you’re unsure how to read the ruler!

#### 📏 Step 2: Complete the Measurement Chart

Use a chart like this to keep your data organized:

| **Object** |  **Length (cm)** |  **Length (in)** |  **Width (cm)** |  **Width (in)** |
| --- | --- | --- | --- | --- |
| Pencil |  |  |  |  |
| Eraser |  |  |  |  |
| Spoon |  |  |  |  |
| Stick |  |  |  |  |
| Crayon |  |  |  |  |
| Cube |  |  |  |  |

#### 🧠 Step 3: Sort the Objects

1. Now look at your chart.
2. Use your **length (cm)** column to **rank** your objects:
	* Line them up **from shortest to longest**.
3. If two items are the same length, place them side by side.

### 📊 Analyze & Record:

Answer the following questions:

* 🥇 **Which object is the longest?** → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* 🥈 **Which is the shortest?** → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* 🤔 **Did any two objects have the same length?** ☐ Yes ☐ No
	+ If yes, which ones? → \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* 🎉 **What surprised you about your measurements or sorting?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 2: Magnetic Mystery!**

**Focus:** Magnet Testing & Simple Problem Solving
**NGSS Standard:** **3-PS2-4**

### **Goal**:

Test different materials to see if they are magnetic, and then design a creative tool, gadget, or solution that uses magnets to solve a problem!

**Materials needed:**

 **Magnets** (bar or disc magnets work well)

 A tray of test items:

* Paper clip
* Coin
* Aluminum foil
* String
* Eraser
* Metal key
* LEGO brick

 **Magnet Test Chart**

 Paper & pencil (for sketching or design brainstorming)

**Student Directions:**

#### Step 1: Test the Items

1. Pick up the **magnet** and gently touch it to each item.
2. **Does the item stick to the magnet?** Try both sides!
3. Write **“Yes”** if the item is magnetic and **“No”** if it isn’t.

Use a chart like this:

| **Test Item** | **Magnetic? (Yes/No)** |
| --- | --- |
| Paper Clip |  |
| Coin |  |
| Foil |  |
| String |  |
| Eraser |  |
| Key |  |
| LEGO Brick |  |

#### 💡 Step 2: Think Like an Inventor!

Now that you know which items are magnetic, try solving a design challenge:

🎯 **Design Task:**
Can you **create or imagine something useful that uses a magnet** to make life easier, safer, or more fun? (Think: secret locker, magnetic toy, cabinet lock, a trapdoor, floating train, etc.)

#### ✏️ Step 3: Sketch or Describe Your Idea

On the back of your worksheet or below, **draw a simple design** that uses a magnet to solve a problem. Label the parts and describe what it does.

**Design Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🧠 **What problem does it solve?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🎨 **Sketch your idea here (or describe it if you prefer):**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### ✅ Reflection Questions:

* Why do some materials stick to magnets but others don’t?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* What was the most surprising material that did (or didn’t) stick?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How could you improve or test your magnet-powered design further?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 3: Light It Up!**

**Focus:** Energy Transfer & Circuits
**NGSS Standard:** **4-PS3-4**

### **Goal:**

Your goal is to **build a working circuit** using batteries, wires, and a lightbulb or LED to **transfer electrical energy into light**!

**Materials needed:**

 Battery pack (with 2 AA batteries installed)

 LED light or small light bulb

 Wires with alligator clips

 Paperclips or foil (for optional switch)

 Optional: Multimeter (to measure voltage)

**Student Directions:**

#### Step 1: Build Your Circuit

1. Connect one wire from the **positive (+) side of the battery pack** to one side of the **LED or bulb**.
2. Connect a second wire from the **other side of the LED/bulb** back to the **negative (–) side of the battery pack**.
3. When both connections are complete, the **light should turn on**!

➡️ If it doesn’t light up, check:

* Are the wires connected tightly?
* Is the LED facing the right direction? (Try flipping it—LEDs have polarity!)

#### 💡 Step 2: Test Energy Transfer

* Watch what happens when the circuit is closed (connected all the way).
* What do you **see**, **feel**, or **hear** that shows energy is moving?

#### 🧲 Step 3: Make a Switch (Optional)

1. Disconnect one wire from the battery pack.
2. Insert a **paperclip** or small piece of **aluminum foil** between the wire and the battery terminal.
3. Try **touching or separating** the foil to open or close the circuit—does your light now work like it’s on a switch?

#### 🔍 Step 4: Use a Multimeter (Optional)

* Connect the multimeter to the battery pack to see how many volts are being sent through the wires.
* Try testing the voltage when the light is **on vs. off**.

### 📝 Record It:

| **Observation Prompt** | **Your Notes** |
| --- | --- |
| 💡 Did your circuit work? | ☐ Yes ☐ No |
| ⚡ What materials helped transfer the energy? | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 🛠️ What could you improve or add to your design? | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 💭 What do you think would happen with more batteries? | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

### 💬 Discussion Prompts:

* What kind of energy did you start with? What kind did you end with?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Why is it important for circuits to be closed (connected fully)?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Where else do you see circuits or switches in real life?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🧠 Wrap-Up Questions (Discuss or Write):**

1. Why is it important to measure things in science?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What was your favorite tool to use and why?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What did you learn about magnets or circuits that surprised you?
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_