**🧠 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?

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**NGSS Standard:**
**HS-PS3-3** – Design, build, and refine a device that works within given constraints to convert one form of energy into another.
**HS-ETS1** – Engineering Design: Define problems, develop models, test and refine solutions.

**✅ ITEEA STEL Standards – High School**

**STEL 1E** – *Technological systems use inputs, processes, outputs, and feedback to solve problems.*
→ Students build a mechanical system (arm, ramp, or launcher) that uses energy input (rubber band, spring), processes it into motion, and outputs a signal (LED or buzzer) to indicate success.

**STEL 2E** – *Technological systems are made up of interactive parts.*
→ This challenge includes integrated mechanical and electrical components—showing how motion, measurement, and feedback work together.

**STEL 7F** – *Technological products and systems can be used to apply energy in a variety of ways.*
→ Students use energy transformation: stored energy → motion, or electrical → light/sound.

**STEL 8F** – *Design involves a set of steps that can be performed in different sequences and repeated as needed.*
→ The activity emphasizes the **engineering design process**: plan, build, test, improve.

**STEL 10F** – *The process of making involves converting materials into usable products.*
→ Students physically construct a working device from common materials—demonstrating skills in fabrication and design.

**STEL 11F** – *Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.*
→ Students sketch, test, troubleshoot, and reflect—mirroring real-world engineering workflows.

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

**CCSS.MATH.CONTENT.HSN.Q.A.1** – *Use units to understand problems and guide the solution.*
→ Measurement tools like rulers and protractors are used to guide decisions in design and performance evaluation.

**CCSS.MATH.CONTENT.HSN.Q.A.3** – *Choose a level of accuracy appropriate to limitations on measurement.*
→ Students must measure distance or angle carefully to evaluate arm/ramp performance.

**CCSS.MATH.CONTENT.HSG.MG.A.3** – *Apply geometric concepts in modeling situations.*
→ Students use geometry and spatial reasoning to design, align components, and measure forces (e.g., lever arms, angles).

**CCSS.MATH.PRACTICE.MP4** – *Model with mathematics.*
→ Calculations or comparisons of motion and energy output (e.g., number of turns, angle traveled) model real-world mechanical motion.

**CCSS.MATH.PRACTICE.MP5** – *Use appropriate tools strategically.*
→ Use of measuring devices, multimeters, and simple electronics (buzzer, LED) demonstrates tool-based problem-solving.

**✅ Summary:**

This **Final Engineering Challenge** is a **capstone project** that synthesizes:

* Engineering and design thinking (ITEEA STEL)
* Measurement, accuracy, and real-world math application (Common Core)
* Energy transformations and systems thinking (NGSS)

It prepares students to think like real engineers—designing not just for function, but also for efficiency, precision, and signal-based automation.