**🧪 MATERIALS (per team):**

All items should be cheap, common, or classroom-friendly!

* 1 plastic spoon
* 6–8 craft/popsicle sticks
* 4 rubber bands
* 1 paper clip or binder clip
* 1 cotton ball or pom-pom (projectile)
* Ruler or measuring tape
* Stopwatch or phone timer
* Target (paper plate, cup, or bullseye printed sheet)
* Data sheet (can be drawn by students)

**STATION 1: "Build-a-Launcher" – Design for Distance**

### **NGSS Connection: HS-PS3-3 (Energy Conversion)****YOUR MISSION:**

You’re taking on the role of an energy engineer! Your goal is to design, build, and test a cotton ball launcher that turns stored energy into motion. Test different launch angles and pull-back distances to send your cotton ball flying as far and accurately as possible. Let’s build for distance!

### **FOCUS:**

Explore how potential energy (from rubber bands or tension) transforms into kinetic energy to launch a cotton ball. Use data and design thinking to improve your launcher’s performance.

### **MATERIALS NEEDED:**

* Craft sticks (popsicle sticks)
* Rubber bands
* Plastic spoon
* Cotton balls
* Tape
* Paper clips or binder clips (for stability)
* Ruler or measuring tape
* Protractor (to measure launch angles)
* Target markers (for 1m and 2m goals)
* (Optional) Stopwatch (to explore time in flight)

**Student Directions:**

**STEP 1: Base Structure:**

* + Use craft sticks and rubber bands to build a strong, stable base.
	+ Stack 5–6 sticks and wrap rubber bands around both ends to form the body.
	+ Use a few more sticks and rubber bands in a cross shape to form a sturdy support.

**STEP 2: Attach the Launcher Arm:**

* + Use a plastic spoon as your catapult arm.
	+ Secure the spoon to the top stick using a rubber band so it can pivot (flex and launch).
	+ You can also tape it to a single stick and wedge it into your base for better tension.

**STEP 3: Stabilize the Frame:**

* + Use clips or extra sticks to keep the base from moving during launch.
	+ Reinforce any wobbly parts with tape or extra rubber bands.

**Test and Measure:**

**STEP 4: Launch the Cotton Ball:**

* + Place a cotton ball in the spoon.
	+ Pull the spoon back to different angles (e.g., 30°, 45°, 60°).
	+ Let go and launch!

**STEP 5: Record Your Data:**

* + For each test, measure and write down:
		- Pull-back distance (cm or degrees)
		- Launch angle
		- Distance the cotton ball travels (in cm or meters)

**STEP 6: Repeat for Accuracy:**

* + Try launching from the same angle 3 times — are your results consistent?
	+ Challenge yourself to hit a target at:
		- 🎯 1 meter
		- 🎯 2 meters

**Challenge Mode – Improve Your Design:**

* Adjust your launcher:
	+ Change the number of sticks, the placement of the spoon, or how tightly you wrap the rubber bands.
* Try different materials or tension styles to make your launch go farther or straighter.

**💬 Wrap-Up Prompts:**

**1. How did changing the spoon angle or pull-back distance affect the launch?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. What energy changes happened during the launch?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. If you wanted to improve your design, what would you change and why?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🏗️ Station 1: “Build-a-Launcher” – Design for Distance**

**NGSS: HS-PS3-3** – Design, build, and refine a device that works within given constraints to convert one form of energy into another.

**✅ ITEEA STEL Standards – High School Level**

**STEL 1H** – *Energy can be used to do work using many technologies.*
→ Students observe and analyze how stored potential energy in the spoon converts to kinetic energy to launch a projectile.

**STEL 4H** – *Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.*
→ Learners engage in hands-on iterative design, refine based on performance, and improve accuracy and range.

**STEL 6G** – *Optimization is an ongoing process or methodology of designing or making a product more effective.*
→ Students optimize launcher performance by modifying materials, angles, and tension systems.

**STEL 7G** – *Creativity and innovation develop problem-solving skills.*
→ Designing, testing, and tweaking their catapult promotes inventive thinking and applied engineering solutions.

**STEL 8G** – *The design process is a purposeful, iterative approach to problem solving.*
→ Students follow a structured build-test-redesign loop to improve their launcher's precision and effectiveness.

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

**CCSS.MATH.CONTENT.HSG.MG.A.1** – *Use geometric shapes, their measures, and their properties to describe objects.*
→ Students work with angles (e.g., 30°, 45°, 60°) and relate them to projectile distance.

**CCSS.MATH.CONTENT.HSN.Q.A.1-3** – *Reason quantitatively and use units to solve problems.*
→ Students measure launch distance, convert units (cm to m), and analyze data across multiple trials.

**CCSS.MATH.CONTENT.HSS.ID.A.1** – *Represent data with plots on the real number line (dot plots, histograms, box plots).*
→ Students may graph launch distances to visualize consistency and analyze variation in repeated trials.

**CCSS.MATH.CONTENT.HSS.ID.C.7** – *Interpret the slope (rate of change) and intercept of a linear model in the context of the data.*
→ If advanced students model angle vs. distance, they may analyze slope to understand energy efficiency or projectile trajectory.

**💡 Summary:**

This activity encourages students to **apply physics and engineering** through hands-on construction, while integrating **mathematical modeling**, **measurement**, and **data interpretation**. It aligns well with **real-world STEM design practices**, pushing students to think like engineers and problem-solvers.