**NGSS HS Catapult Kit Activity**

**🏹 STICKY LAUNCH CHALLENGE**

**Theme:** *Use everyday materials to measure and master motion!*
**Objective:** Design and measure a simple projectile launcher to explore force, energy, and motion using real-world physics concepts.

**🌟 OVERVIEW**

Students will build a **mini catapult or launcher** using easy-to-find materials, test launch distances and angles, and collect and analyze data to understand **Newton’s Laws**, **energy transformation**, and **momentum**.

**🧪 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)**
**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 2: "Motion Math" – Measure Acceleration & Momentum**

**NGSS Connection: HS-PS2-1 & HS-PS2-2**
**Student Directions:**

**🧪 Set Up:**

**STEP 1: Choose your projectile:**

* + Start with a cotton ball (light mass).
	+ You'll test different masses later!

**STEP 2: Set up your launcher** (from Station 1 or use the same kind):

* + Make sure it’s stable and ready to fire in a straight line.

**STEP 3: Mark a start line** and use tape or a ruler to create a **measuring track** (at least 2 meters long if possible).

**⏱️ Collect Motion Data:**

**STEP 4: Measure Distance:**

* + Use a tape measure or ruler to mark where the projectile lands.
	+ Record how far it traveled (meters or centimeters).

**STEP 5: Measure Time:**

* + Use a stopwatch or timer to record how long the projectile is in motion (from launch to landing).
	+ Have one student time while another launches.

**STEP 6: Repeat 3 times** for accuracy. Then change mass (e.g., small eraser, aluminum foil ball, or coin) and repeat.

**✏️ Do the Math:**

**STEP 7: Estimate Average Speed (v):**

**Calculate Acceleration (a):**
Use this formula:

**Calculate Momentum (p):**
First, record the estimated mass of your object in kg (e.g., 0.01 kg for a cotton ball). Then:



 **Data Table Example:**

| **Object** | **Mass (kg)** | **Distance (m)** | **Time (s)** | **Speed (m/s)** | **Acceleration (m/s²)** | **Momentum (kg·m/s)** |
| --- | --- | --- | --- | --- | --- | --- |
| Cotton Ball | 0.01 |  |  |  |  |  |
| Heavier Object | 0.05 |  |  |  |  |  |

 **Reflection Prompts:**

**1. How did changing the mass of the projectile affect the speed and momentum?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. Was more pull-back (tension) always better for distance or speed? Why or why not?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. What patterns do you notice in how mass, speed, and momentum are connected?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🔁 STATION 3: "Energy Detective" – Potential → Kinetic**

**NGSS Connection: HS-PS3-1 & HS-PS3-2**
**Student Directions:**

**🧪 Setup:**

1. **Use your catapult or spoon launcher** from Station 1.
2. **Mark pull-back distances** on the spoon (e.g., 2 cm, 4 cm, 6 cm). Use a ruler and a marker or tape.
3. Get a **cotton ball or small projectile** to test.

**🧠 Investigate Energy:**

1. **Choose a pull-back distance** (e.g., 2 cm) and launch your projectile.
2. Measure and record:
	* **Pull-back distance** (how far the spoon bends back).
	* **Distance traveled** (use a meter stick or tape measure).
	* **Time in motion** (use a stopwatch if possible).
3. Repeat with **different pull-back distances** (4 cm, 6 cm, etc.).
4. Watch how the **distance and speed** change with more potential energy stored.

**📏 Data Table Example:**

| **Trial** | **Pull-Back Distance (cm)** | **Estimated Potential Energy (more = higher)** | **Distance Traveled (m)** | **Observations** |
| --- | --- | --- | --- | --- |
| 1 | 2 | Low |  |  |
| 2 | 4 | Medium |  |  |
| 3 | 6 | High |  |  |

**Science Connection:**

**Potential Energy** = stored energy in the bent spoon
**Kinetic Energy** = energy of motion when the object flies through the air

Use this simple energy model:



**💬 Reflection Prompts:**

**1. Where was the energy stored before the launch?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. Where did the energy go after the launch?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. What happened when you increased the pull-back distance?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4. How do you think real machines (like bow and arrows or springs) use this same principle?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🧠 BONUS STATION: "Target Tracker" – Design for Precision**

1. **NGSS Connection: HS-ETS1 (Engineering Design)**
**Set up 3 targets** at different distances:
	* Close (0.5–1 meter)
	* Medium (1.5 meters)
	* Far (2+ meters)
	You can use cups, boxes, paper targets, or chalk circles.
2. Use your existing **launcher** (from previous stations) or make small changes (change rubber band tension, angle, base stability, etc.).

**📏 Test and Collect Data:**

1. For each distance, **launch 3 times**.
2. **Record hits vs. misses** for each target.
3. Track:
	* **Angle of spoon or arm** (estimate in degrees)
	* **Pull-back distance**
	* **Launcher design version (Original, Modified 1, Modified 2)**

**📊 Data Table Example:**

| **Target Distance** | **Launcher Version** | **Angle** | **Pull-Back (cm)** | **Hits** | **Misses** | **Notes** |
| --- | --- | --- | --- | --- | --- | --- |
| Close | Original | 45° | 3 | 2 | 1 |  |
| Medium | Modified 1 | 60° | 4 | 1 | 2 |  |
| Far | Modified 2 | 75° | 6 | 3 | 0 |  |

**🔁 Redesign and Improve:**

1. Use your results to **modify your launcher**:
	* Change angle
	* Add a stopper for consistency
	* Adjust base support
	* Change rubber band or pull-back length
2. **Test again** to see if your accuracy improves!

**💬 Target Tracker Reflection Prompts:**

**1. What changed between your first and final designs?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. What worked best for hitting targets accurately?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. Which design choices helped transfer energy more efficiently?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4. What real-world machines use similar energy and motion concepts?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**5. How did measuring and data collection help you improve?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**NGSS MS Catapult Kit Activity**

**🏹 NGSS Catapult Station Challenge: Launch, Measure, and Master the Motion!**

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

🎯 **Your Mission:**
You are a medieval engineer! Rotate through the catapult stations to explore how **force**, **mass**, and **angle** affect your launch. Use your data to redesign your catapult for better **accuracy and energy performance**.

**🧱 Station 1: Build Your Catapult**

🔬 **NGSS: Engineering Design Prep – (Foundation for MS-PS2-1, MS-PS3-1)**
**Goal:** Construct a working catapult that can safely and consistently launch soft objects.

**Materials at this station:**

* Popsicle/craft sticks
* Rubber bands
* Plastic spoon or bottle cap
* Binder clips or clothespins
* Tape

✅ **Student Directions:**

**STEP 1:. Plan Your Catapult**

* Think about how a lever works: the spoon will be the arm, and you’ll need a base to hold it steady.
* Decide how many sticks to use for the base and how to position the launch arm.

**STEP 2: Build the Frame**

* Stack and rubber-band **at least 5–6 sticks** together for your base.
* Use **2–3 sticks** crossed or spaced out to make a base where the spoon can rest.
* Secure with rubber bands or tape so nothing wobbles or slides.

**STEP 3: Attach the Launch Arm**

* Tape or rubber-band the **spoon** or **bottle cap** to a stick that acts as the lever arm.
* Insert this lever through a small opening in the base so it can pivot (act like a seesaw).

**STEP 4: . Secure and Stabilize**

* Use **binder clips or clothespins** to hold the base firmly to the table if needed.
* Test how far the arm can pull back without snapping or breaking.
* Adjust as needed to make the launch smooth and consistent.

**✏️ Sketch Your Design Below:**

*(Label important parts like base, launch arm, and stabilizers)*
📐 Use arrows to show where energy is stored and released!

**💡 Helpful Tips:**

* The more the spoon bends back, the more potential energy you store!
* Stability = consistency → make sure your base doesn’t shift during launch.
* You’ll modify and test this design in other stations—this is just the start!

**🚀 Station 2: Force vs. Distance**

🔬 **NGSS: MS-PS2-2 – Effects of Force on Motion**
**Goal:** Investigate how increasing the force (via rubber bands) affects distance.

**Materials at this station:**

* Catapult
* Rubber bands (vary amount)
* Cotton ball or pom-pom
* Ruler or measuring tape

 **Student Directions:**

 **1. Prepare Your Catapult**

* Attach **1 rubber band** to your catapult arm.
* Place your cotton ball or pom-pom in the spoon/cap.

 **2. Test the Launch**

* Pull back to the same angle or position each time (use a consistent launch angle like 45° if possible).
* Launch the cotton ball and **measure the distance** it travels using the ruler or tape.
* **Record your measurement** in the table.

 **3. Repeat with 2 and 3 Rubber Bands**

* Add a second rubber band and repeat the same launch setup.
* Then try with 3 rubber bands.
* Measure and record the distance each time.

**Data Table:**

| **Rubber Bands** | **Distance Traveled (cm)** |
| --- | --- |
| 1 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 2 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 3 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

 **Analysis Question:**

**What pattern do you notice between the number of rubber bands and the distance traveled?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**💡 Hints for Success:**

* Keep your **launch angle and technique the same** each time so the only variable is the number of rubber bands.
* Use the **same projectile** and **measure from the same starting point**.

**🔺 Station 3: Launch Angle & Flight**

🔬 **NGSS: MS-PS2-2 – Motion Patterns Based on Angle**
**Goal:** Test how the angle of launch affects projectile distance.

**Materials at this station:**

* Your completed catapult
* Protractor or printed angle guides (for 30°, 45°, 60°)
* Ruler or tape measure
* Cotton ball or pom-pom (same projectile for all tests)
* Notebook or recording sheet

✅ **Student Directions:**

**🔧 1. Set Up Your Launch Angle**

* Use a **protractor or angle guide** to tilt your catapult arm to each target angle.
* You can also mark pull-back positions if that helps keep your angles consistent.

**🎯 2. Test at 30°**

* Launch your projectile at a 30° angle.
* Measure from the front of your catapult to where the projectile lands.
* **Record your measurement** in the table.

**🔁 3. Repeat for 45° and 60°**

* Adjust the angle carefully each time.
* Keep everything else (pull-back amount, projectile type) the same.
* Launch and measure for both 45° and 60° angles.

**📊 Data Table:**

| **Launch Angle** | **Distance Traveled (cm)** |
| --- | --- |
| 30° | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 45° | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 60° | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**✏️ Analysis Question:**

**Which angle gave the longest launch distance? Why do you think that angle worked best?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**💡 Hints for Success:**

* Make sure to launch from the same surface and height.
* Keep the rubber band tension and projectile consistent.
* Record any observations—Did the projectile go higher, shorter, or straighter?

**⚡ Station 4: Graphing Energy**

🔬 **NGSS: MS-PS3-1 – Kinetic Energy & Speed Relationship**
**Goal:** Measure the projectile's speed and calculate kinetic energy (KE).

**Materials at this station:**

* Catapult
* Stopwatch
* Measuring tape
* Graph paper (optional)

✅ **Student Directions:**

**Step 1: Set up your station.**

* Place the catapult on a flat surface.
* Measure and mark a straight distance (e.g., 1 meter) using the measuring tape.

**Step 2: Launch the projectile.**

* Place a cotton ball in the catapult.
* Launch it and **start the stopwatch** as soon as the cotton ball is released.
* **Stop the stopwatch** when the cotton ball reaches the target distance or hits the ground.
* Record the **time** it took.

**Step 3: Measure the distance.**

* If the cotton ball didn’t travel exactly 1 meter, use the measuring tape to record the actual distance it traveled.

**Step 4: Calculate the speed.**
Use the formula:



Record your result in the data table.

**Step 5: Calculate kinetic energy (KE).**
Use the formula:



* The cotton ball’s mass is approximately **0.0005 kg**.
* Calculate and record the KE in joules (J).

**Step 6: Repeat for 3 trials.**

* Complete at least 3 launches.
* Record the distance, time, speed, and KE for each trial.

| **Trial** | **Distance (m)** | **Time (s)** | **Speed (m/s)** | **KE (J)** |
| --- | --- | --- | --- | --- |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

**Step 7 (Optional): Graph your results.**

* On graph paper, plot **Speed (x-axis)** and **KE (y-axis)** for your 3 trials.
* Observe the shape of the curve and how KE changes as speed increases.

✏️ **What do you notice?**
**→ What happens to KE as speed increases?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**🎯 Station 5: Redesign for Accuracy**

🔬 **NGSS: MS-PS2-1 – Motion & Net Force (Accuracy through redesign)**
**Goal:** Modify your catapult to improve accuracy and hit a 100 cm target.

**Materials at this station:**

* Catapult
* Paper hoops or target markers
* Measuring tape
* Projectiles of different mass (e.g., cotton balls, mini pom-poms, etc.)
* Stopwatch (optional for timing launches)
* Ruler or protractor (optional for angle measurements)

 **Student Directions:**

**Step 1: Set up your target.**

* Place your paper hoop or designated target **exactly 100 cm away** from the front of the catapult.
* Use the tape measure to be as accurate as possible.

**Step 2: Initial test launch (No modifications).**

* Use your default catapult setup.
* Launch your projectile **5 times** toward the target.
* Count how many times you hit the target.
* Write your score here:
**🎯 Target Hits (out of 5): \_\_\_\_\_\_**

**Step 3: Start redesigning!**

* Choose one variable to adjust at a time. You can try:
	+ ⬆️ **Changing the angle** of the catapult arm
	+ 🟰 **Adjusting rubber band tension**
	+ ⚖️ **Switching to a different projectile mass**
	+ 🪵 **Changing the base height or stability**

**Step 4: Test your redesigned catapult.**

* After making a change, **launch again 5 times**.
* Record the number of hits and what you changed.

**Step 5: Repeat and refine.**

* Keep redesigning, but only **change one variable at a time** so you can tell what made the difference.
* Try **at least 2 redesigns**.

 **Redesign Notes Table (Use your notebook or worksheet):**

| **Redesign #** | **What did you change?** | **Hits out of 5** |
| --- | --- | --- |
| 1 |  |  |
| 2 |  |  |
| 3 (if any) |  |  |

 **Which change improved accuracy the most?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Wrap-Up Reflection**

**NGSS Connections: MS-PS2-1, MS-PS2-2, MS-PS3-1, MS-PS3-2**

1. 💥 **How did energy change from potential to kinetic in your catapult?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. 🏹 **Which variable had the biggest effect on motion—force, angle, or mass? Why?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. 💪 **If you needed to launch a heavier object farther, what would you change?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**NGSS ES Catapult Kit Activity**

Absolutely! Here's a **creative, NGSS-aligned catapult activity** designed for **elementary students (Grades 3–5)**. It's simple, hands-on, and uses easy-to-find materials while encouraging students to explore **forces, motion, energy transfer, and patterns** through **fun experimentation** and **engineering design**.

**🏗️ Catapult Creators: Launch & Learn!**

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

**🎯 Your Mission:**

You're an engineer designing a mini catapult! Today, you'll build a launcher and test how **force** and **energy** affect how far your object travels. Track your results, look for patterns, and improve your design for accuracy and power!

**📍 Station 1: Build It!**

 **NGSS: 3-5-ETS1-1 – Engineering Design (Building under constraints)**

🛠️ **Materials:**

* 7 craft sticks or popsicle sticks
* 4 rubber bands
* 1 plastic spoon
* Cotton balls or pom-poms (projectiles)
* Measuring tape or ruler
* Target (paper cup or printed bullseye)
* (Optional) masking tape, clipboard, or tray

👣 **Student Directions:**

**Step 1: Build the base of your catapult.**

1. Stack **5 popsicle sticks** neatly on top of each other.
2. Wrap **1 rubber band tightly** around each end to hold them together.
	* ✅ This is your **base block**.

**Step 2: Add the launch arms.**

1. Take the remaining **2 sticks** and stack them together.
2. Gently pull the two sticks apart in the middle to form a **V-shape** and slide them **between the 5-stick base**, making a cross shape.

* It should look like the top 2 sticks are “biting” through the middle of the base.

**Step 3: Add the launching spoon.**
1. Use a rubber band to **attach the plastic spoon** securely to the **top stick** of the V (the launching arm).

* Make sure the spoon bowl is facing upward and sticks out over the end.

**Step 4: Secure the structure.**
1. Use the **last rubber band** to secure the **2 V-sticks** to the base block.

* Wrap it around the intersection where the V-sticks meet the base to keep the whole thing tight and sturdy.

**Step 5: Test for stability.**
1. Press down lightly on the spoon to see how far it goes and make sure the base doesn’t fall apart.

* If it’s wobbly, add more rubber bands or ask for a tray/clipboard to tape it down.

**🖼️ Sketch Your Catapult Design Below**

(Draw and label each part of your catapult: base sticks, V-sticks, spoon, rubber bands, etc.)
✏️ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
✏️ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
✏️ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 2: Force & Motion Fun**

**NGSS: 3-PS2-1, 4-PS3-1**

**🛠️ Materials at this station:**

* Your completed catapult
* Cotton balls or pom-poms (projectiles)
* Measuring tape or ruler (marked in centimeters)
* Data table (provided on your worksheet or in your notebook)
* Pencil or pen

**Student Directions:**

**Step 1: Set up your launch area.**

* Use the measuring tape to create a clear path where you will launch the cotton ball.
* Place your catapult at the “0 cm” starting line.

**Step 2: Load your projectile.**

* Place one cotton ball in the spoon of your catapult.

**Step 3: Test with LOW force.**

* Gently pull the spoon back **just a little bit**—this is a **small or low force**.
* Let go and **watch where the cotton ball lands**.
* Use the measuring tape to measure how far it flew (from the front of the catapult to the landing spot).
* Write the **distance in centimeters** in the data table.
* Write an **observation** (e.g., "It barely moved," or "It rolled a short distance").

**Step 4: Test with MEDIUM force.**

* Pull the spoon back **about halfway**—this is **medium force**.
* Launch, measure, and record your results and observation.

**Step 5: Test with HIGH force.**

* Pull the spoon **all the way back**, as far as it can go without breaking.
* Launch, measure, and record the final distance and your observations.

 **Record Your Results Below:**

| **Pull Force** | **Distance (cm)** | **Observation** |
| --- | --- | --- |
| Low |  |  |
| Medium |  |  |
| High |  |  |

 **Reflection Question:**

**→ What did you notice about how the force changed the motion of the cotton ball?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 3: Aim for the Target!**

**NGSS: 3-PS2-2, 4-PS3-4**

**🎯 Your Mission:**

Test how well your catapult can **hit a target** placed exactly **100 cm away**. You’ll try launching **3 times**, changing the **angle** or **pull-back force** to improve your aim. Track your results and record what changes helped you aim better!

**🛠️ Materials at this Station:**

* Your built catapult
* 3 cotton balls or pom-poms
* 1 paper cup or printed target
* Measuring tape
* Ruler (optional for measuring angle)
* Data table and pencil

**Student Directions:**

**Step 1: Set up your target.**

* Use a measuring tape to place the paper cup or printed target exactly **100 cm (1 meter)** away from your catapult.
* Mark the spot where your catapult will stay. Do **not** move it during testing.

**Step 2: Get ready for Trial #1.**

* Use your default setup—don’t change anything yet.
* Pull back your catapult and launch the cotton ball toward the target.
* Record in the chart if you **hit or missed**.
* If you missed, take a note of what might have gone wrong.

**Step 3: Adjust and try again!**

* **Trial #2:** Change **one thing**—either the **angle of launch** or how far you **pull back the spoon**.
* Launch again and record the result.
* Write down what you changed to improve your aim.

**Step 4: One last adjustment.**

* **Trial #3:** Try again and adjust a **different variable** if needed (maybe use more force or lower the spoon angle).
* Launch, observe, and record your result in the table.

**📋 Record Your Results Below:**

| **Try #** | **Did You Hit the Target?** | **What Did You Change?** |
| --- | --- | --- |
| 1 | ☐ Yes  ☐ No | (default settings) |
| 2 | ☐ Yes  ☐ No | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 3 | ☐ Yes  ☐ No | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**💡 Wrap-Up Question:**

**→ What helped improve your accuracy the most?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**📍 Station 4: Find the Pattern!**

**NGSS: 3-PS2-2**

**🎯 Your Mission:**

Experiment with your catapult by launching at **three different angles**: 30°, 45°, and 60°. Measure how far the cotton ball travels for each angle. Then, look for patterns and figure out which launch angle works best!

**🛠️ Materials at this Station:**

* Your completed catapult
* Cotton balls or pom-poms
* Ruler or measuring tape
* Angle guide (or printed protractor card)
* Data table
* Pencil

**Student Directions:**

**Step 1: Set up your catapult for 30°**

* Use the angle guide to tilt your catapult to approximately **30 degrees**.
* Secure it in place using tape, a clipboard, or another support if needed.
* Place a cotton ball in the spoon, pull back gently, and **launch**.
* Measure how far the cotton ball travels from the catapult to where it first hits the ground.
* **Record the distance (in cm)** in your data table.

**Step 2: Test at 45°**

* Adjust your catapult’s launch angle to **45 degrees**.
* Launch again, measure the distance, and record it.

**Step 3: Test at 60°**

* Tilt your catapult to a **60-degree angle**.
* Launch, measure, and record the result.

**📋 Record Your Results Below:**

| **Launch Angle** | **Distance Traveled (cm)** |
| --- | --- |
| 30° |  |
| 45° |  |
| 60° |  |

**⭐ Think About It:**

**→ Which launch angle helped the cotton ball travel the farthest? Why do you think that angle worked best?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**💬 Wrap-Up Reflection**

1. **What did you learn about force and motion today?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. **How did your catapult change stored energy into motion?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. **If you could make a super-powered catapult, what would you add or upgrade?**
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
→ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_