**🚀 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.

**🚀 YOUR MISSION:**

You’re testing how power affects performance! Your challenge is to launch a cotton ball using different amounts of force (by adding rubber bands) and measure how far it travels. Keep everything else the same—your goal is to find out how force changes motion!

**🎯 FOCUS:**

Force, Motion & Distance Traveled

**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 2: Force vs. Distance**  
🔬 *NGSS Connection:* MS-PS2-2 – Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

✅ **ITEEA STEL Standards – Middle School**

* **STEL 1F** – *Technological systems include inputs, processes, and outputs.*  
   → Students change input force (number of rubber bands) to affect the system output (launch distance).
* **STEL 2E** – *Systems thinking involves understanding how parts influence one another within a system.*  
   → Students investigate how the tension in rubber bands interacts with the catapult’s arm and projectile motion.
* **STEL 3F** – *Design is a creative process for solving problems.*  
   → Students modify the design (number of bands) to improve performance and observe patterns.
* **STEL 4F** – *The engineering design process includes brainstorming, testing, and improving designs.*  
   → They test, collect data, and analyze how their catapult performs under different forces.
* **STEL 5D** – *Data is used to evaluate technological systems.*  
   → The recorded launch distances are used to identify trends and assess the effectiveness of force adjustments.

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

* **6.SP.B.5** – Summarize numerical data sets in relation to the context.  
   → Students collect, record, and interpret measured launch distances.
* **6.EE.C.9** – Use variables to represent two quantities that change together in a relationship.  
   → Students analyze how increasing rubber bands (force) affects distance (motion).
* **7.EE.B.4** – Use variables to represent quantities in real-world problems and construct equations or inequalities.  
   → This activity lays the foundation for writing expressions to describe force-distance relationships.
* **7.SP.C.7** – Develop a probability model and use it to find probabilities of events; compare theoretical and experimental probabilities.  
   → Can be extended to determine the consistency or predictability of launch distances with repeated trials.
* **8.F.A.3** – Interpret the equation of a linear relationship between two quantities.  
   → Students may begin to discuss or graph the linearity (or lack thereof) between number of rubber bands and distance.

💡 **Summary:**  
This activity aligns with key ITEEA and math standards by encouraging students to **collect and analyze real data** while experimenting with **force and motion** through hands-on engineering. It supports middle school learners in exploring how design and variables impact performance using clear measurement, prediction, and evidence-based conclusions.