Unit 6 (Work & Energy):
Elastic Launcher

Concept

We can use our information about elasticity to select a rubber band that will launch a load a predictable distance.

Content Objective

Students will design and make elastic systems that will launch a wet cotton ball or a ping pong ball to a target. They will select rubber bands and predict the distances based on their data about elasticity.

Language Objective

Cooperate with peers on collaborative building and writing activities.
Predict results of different launches using specific vocabulary: *stored energy, elasticity*, etc.
Explain how device works in cohesive written paragraph.

Standards

- **NGSS:**
  - **5-PS1-3:** Observe and measure to identify materials based on their properties. 5-PS1-4. Investigate whether mixing two or more substances results in new substances.
  - **3-5-ETS1-1:** Define a simple design problem, including criteria for success and constraints on materials, time, or cost.
  - **3-5-ETS1-2:** Generate and compare multiple solutions based on criteria and constraints of the problem.
  - **3-5-ETS1-3:** Plan and carry out fair tests that control for variables and identify failure points to improve a model or prototype.

- **TEKS:**
  - **2A** Students will describe, plan, and implement simple experimental investigations testing one variable.
  - **2C** Students will collect information with detailed observations and accurate measuring.
  - **2E** Students will demonstrate that repeated investigations may increase the reliability of results.
  - **5A** Students will classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.

- **6A** Students will explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy.
- **6D** Students will design an experiment that tests the effect of force on an object.

- **ELPS:**
  - **1E** Students will internalize new basic and academic language by using and reusing it in meaningful ways in speaking and writing activities that build concept and language attainment.
  - **3E** Students will share information in cooperative learning interactions.
  - **5B** Students will write using newly acquired basic vocabulary and content-based grade-level vocabulary.
  - **5G** Students will narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs.

Materials

Design Materials

i. Overhead transparencies/chart paper and pens (1 per team of two); Handouts **5.6.1-5.6.3**

Construction Materials

ii. Cotton balls, ping pong balls, or other safe projectiles; notched wood craft sticks, wood strips, blocks of wood, NEX, LEGOs, or other construction set components; Plastic spoons, cloth, or other material for holding projectiles before launch; Rubber bands of the 3 types used previously; Wood glue or glue gun; Calculators; Safety goggles

Literature Connection

The Three Little Pigs Build a Catapult by Janesa Hendriks and Olivia Petersen

Preparation

Decide on the target (if any) or whether the launching event will be for distance only. You might have students launch wet cotton balls at a bulls-eye marked with points, or; toward lines on the floor that show distance, or into buckets. If you are launching wet cotton balls they will mark butcher paper where they land. Determine what projectile you will use. Plan to monitor construction areas for safety and set safety standards for team practice-launches.

Day 1: Engage *Work & Energy- Elastic Launcher*

Teacher Says/Does	Student Says/Does	Language requirements
1. Write the words *stored energy* and *elasticity* on the board and ask for their definitions. Allow students think time, have them share their definitions with a partner, and then share out to the class. In similar Think, Pair, Share fashion have students think of examples of stored energy around the classroom and then how the energy is then used. Some examples are wind-up toys, or putting loads on springs.	Students think about their responses, discuss with a partner nearby, and then share with the whole group.	Predictions: I predict that _____ will _____. Vocabulary terms:
2. Ask students to review what they found out about elasticity in the last activity. They should have some data on the elasticity of the 3 types of rubber bands. Ask them to label the rubber band supply boxes, if not done so already, with the approximate force per inch the rubber band provides.	Students discuss and label the rubber band boxes.	***Brick words:*** *stored energy, elasticity*, ***Mortar words:*** collaborate, cooperate, predict, device
3. Ask these questions and have students discuss with their teams: • Which rubber band is most stiff? Would it hold the most energy? • Could you use what you learned to make a rubber band-operated toy that launches a ball to a target? (or whatever projectile and goal you will use.)	In teams, students discuss the questions and share their ideas in the whole group.	
4. Have students individually complete the 'What I Know' and 'What I Want to Learn' sections of a KWL chart (**5.3.1**) as their exit slip.	Students complete the KWL chart individually.	

Day 2: Explore/Explain *Work & Energy- Elastic Launcher*

Teacher Says/Does	Student Says/Does	Language requirements
1. **Preparation:** Make a KWL anchor chart by synthesizing the students' responses from the previous lesson's exit slips. 2. Review the KWL chart with the students and add any new information or questions that they have. 3. Show students the target or goal of the launcher activity and present the Design Brief (**5.6.2**). Let the teams investigate some of the variables in using the rubber bands to launch. For example, the distance the rubber band is stretched makes a big difference in available elasticity. Handout **5.6.3** may be used to guide the discussion. 4. Have the teams make drawings on the overhead transparencies or paper to be shown on the document camera. Then hold a design review to go over the plans. Other teams should ask questions. **The students will be held to their choice of rubber band, so this review provides their chance to alter their decision. During the design review they should explain why they are using the rubber band selected.** 5. Let the teams begin construction. While the students are working, use the **Collaborative Dialogue Template** (p. 32 in Teacher Handbook) to guide conversations and take a running record of students' progress on content and language objectives.	Students share additional thoughts and questions for the KWL chart. Students work in teams to experiment with the rubber bands' elasticity. Teams draw the plans for their rubber band launchers. Student teams begin building their launchers.	

Day 3: Elaborate/Evaluate *Work & Energy- Elastic Launcher*

Teacher Says/Does	Student Says/Does	Language requirements
1. After the student teams have finished building their launchers, ask how they might be used in real life. 2. Show examples in sports (for projectile motion), rocketry, aerospace engineering, historical research, and civil engineering. Consider showing the video below: "Projectile Motion" by the Children's Museum of Houston https://www.youtube.com/watch?v=R4LPxQ90ju8 3. Describe how student teams will write and illustrate a creative story that explains the mechanisms, work, energy, and purpose of their launcher. 4. Model how you would identify characters, setting, problem, and solution for the example of putting away laundry from the video above. "Think aloud" so as to make the process more transparent for students. Consider modeling the idea generation process using the graphic organizer below. Also demonstrate how to write the first part of a narrative story.* http://thisreadingmama.com/wp-content/uploads/2012/11/Fiction-Text-Structure-Retelling-Organizer.pdf 5. Circulate around the room as the student teams complete the graphic organizers and write their own stories. *You may want to dedicate an additional class period to having the students rewrite their initial thoughts from the graphic organizer to narrative form as a creative story.	Students share their ideas. Students ask questions and contribute suggestions for the graphic organizer and story writing process. Student teams complete the graphic organizer and use it to write a creative story about their launcher.	***Mortar words:*** characters, setting, problem, solution

Day 4: Evaluate *Work & Energy- Elastic Launcher*

Teacher Says/Does	Student Says/Does	Language requirements
1. After the student teams have built their devices and written the stories, hold the launching event.	Student teams take turns reading their stories. After all teams have presented, then each team launches and records their scores.	
2. Have students share observations of what helped certain devices be more or less successful.	Students share their observations of the stories and launchers.	

Exit Slip: KWL about Elastic Launchers

Name _____ Date _____

Complete the first two columns of the KWL chart. We will revisit the last column to synthesize our learning toward the end of the project.

K **What I Know**	**W** **What I Want to Know**	**L** **What I Learned**

Design Brief: Elastic Launcher

Design Problem	**Words to Remember/ Palabras para recordar**
Design and make a launching device to__ (e.g. 'get a wet cotton ball into a bucket). It must: Use potential energy stored and released by rubber bands. Specifications and constraints: 1. You must use materials available to everyone. 2. You may use the given launcher idea or invent a new one. 3. You should draw and label your plan and present it in a design review. 4. You should use what you know to select the rubber band type and get approval before you begin. 5. You should launch from two different distances. 6. You should use goggles and practice safety at all times— especially during practice launches.	

Drawing or Model of Our Plan (You can use the back of the page, too!):

Steps

Task	**Person Responsible**

Launching Possibilities

You can use notched wood craft sticks and snap together a launcher like this.

<u>You need:</u>

12 or more notched wood craft sticks 1 plastic spoon
1 rubber band for launching
1 rubber band for securing the end of the spoon.

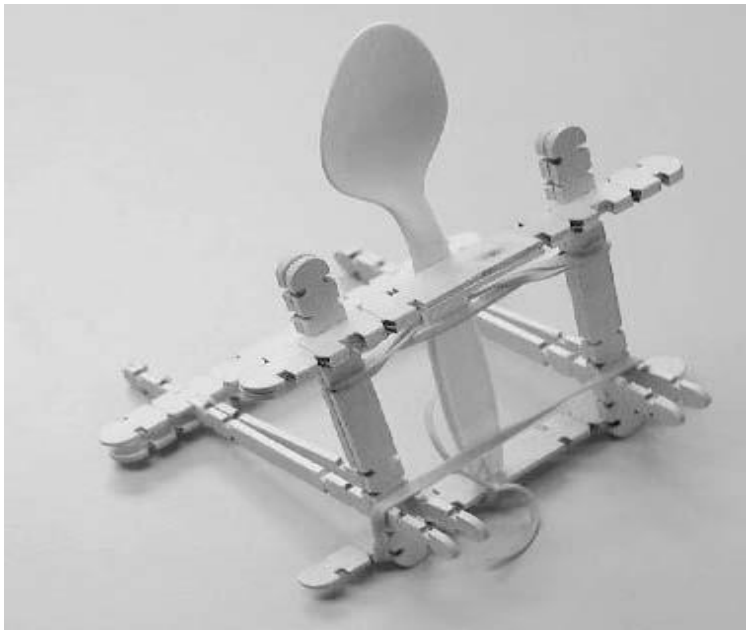

Photo credit: American Chemical Society

<u>To use:</u>

Hold the base of the spoon in place in the frame.
Pull back on the bowl of the spoon and place the projectile in the spoon.
Aim and let go.

Keep a record of your data:

Your prediction: which rubber band will send the projectile farthest?	Rubber band number	Distance in 3 tries			Average distance

Which rubber band had the greatest potential energy? Explain your answer: