Physicist: Marshmallow Catapult

Time: 50 Minutes **Skill Level:** Elementary (age 9-11), Middle School (age 12-14)

Background

What is Science Inquiry?

Children are natural scientists. From a very early age they explore the world, ask questions and seek answers. This journey of exploration and discovery is Science Inquiry. Science Inquiry helps young people understand their environment, solve problems and gain knowledge about scientific ideas and processes.

Next Generation Science Standards (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
1. Asking questions (for science) and defining problems (for engineering)	**PS2:** Motion and stability: Forces and interactions	**2.** Cause and effect: Mechanism and explanation
2. Developing and using models	**PS3:** Energy	**5.** Energy and matter: Flows, cycles, and conservation
3. Planning and carrying out investigations	**ETS1:** Engineering design	**6.** Structure and function
6. Constructing explanations (for science) and designing solutions (for engineering)		

Objective

In this activity students will design a catapult from everyday materials to meet a challenge.

Intro to Physicists

Physicists are scientists that study a wide range of physical phenomena and how different forms of matter and energy interact. Experimental physicists are trained to perform physical experiments in a laboratory. Theoretical physicists are often skilled in math or computer science and create mathematical models to investigate phenomena. Although a physicist's education spans all areas of physics, a physicist often specializes in a particular phenomena (e.g., particles, light, magnetism, etc.). Additionally, many physicists specialize in a field closely related to other sciences, such as astrophysics, biophysics, chemical physics, or geophysics.

The Science of Catapults

A catapult is a mechanical device used to launch an object a long distance. The type of science that describes this kind of motion is called *ballistics*. The launch speed, angle, and gravity completely

The Science of Catapults *(continued)*
determine the object's position at any time, including the final landing position. For this reason, a catapult can be designed to hit a particular target repeatedly and reliably.

One type of catapult design utilizes a spring, which allows the launch arm to bend back and gain *potential energy* (i.e., stored energy). When released, this energy is converted to *kinetic energy* (i.e., energy due to motion), causing the launch arm and object to hurl forward. The launch arm is caught, but the object continues to hurl forward based on the angle and speed at which it left the launch arm.

Materials List:
- Craft sticks
- Rubber bands
- Plastic spoons
- Pencils
- Marshmallows

Discuss …What do students know about how ballistics? Have they seen other examples of projectile motion? For example, shooting a basketball or flicking a penny off the table? How do you change your initial conditions in order to hit your target? Discuss the catapult design. How can these household items be combined to design a catapult?

Predict …Generate Ideas. Select a Solution.

Experience "What to Do"- What is the plan for the investigation?
Identify a challenge for the class, such as a target they need to hit or a "wall" they need to clear. Have each group of students work together to design a catapult to meet the challenge under the same set of constraints, such as the same materials (e.g., 1 pencil, 1 craft stick, and 2 rubber bands) and the same amount of time.

Optionally, you may want to discuss the engineering design cycle and organize the lesson accordingly. The engineering design cycle consists of six steps: (1) State the Problem, (2) Generate Ideas, (3) Select a Solution, (4) Build the Item, (5) Evaluate, (6) Present results.

Share …Encourage students to discuss their design, its successes, and its challenges.

Reflect …**Analyze and interpret the data and results. Discuss among the group.** After each group has tested their design, ask the groups to modify their design—either to improve its design, or adapt to another challenge (e.g., a different target). Optionally, you can offer additional materials at this time, such as additional rubber bands or craft sticks.

Generalize …**to real world examples. Construct explanations.** Discuss the re-design process. How did students know what to change?

Apply …**outside the classroom or club meeting.** Why were catapults popular in ancient times? What are some drawbacks or limitations that may have spurred innovation to other technologies?

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