MINI CATAPULTS (G3–6)

In this workshop, students will engineer a working catapult to take home. The Works Museum's educators will provide a prescribed set of materials to use during building, basic instructions, and a variety of examples for students to use as their construction guides. Educators will also instruct and monitor students for safe tool use. Students will have time to test their catapults' flinging ability in order to refine the design and understand how projectiles fly. See p. 3 for standards this workshop supports.

SCIENCE CONCEPTS

Catapults are excellent examples of objects made of smaller components, including **simple machines**.

- The catapult has many different parts that each perform an important job: the base, the launch arm, etc.
- The launch arm is a **lever** that rests on a **fulcrum**.
- The choices students make in designing and building each part affect the performance of the finished catapult.

Objects move because of forces.

- Students pull back on the catapult, powering it up with **potential energy**.
- When released, the energy is transferred to the **kinetic energy** of the catapult's moving arm, which pushes a projectile, making it move in turn.
- **Gravity** and **air resistance** eventually stop the projectile.

Educators will also stress the Engineering Design Process to students.

- Students will have ample time to test their catapults with provided projectiles.
- They will investigate weak areas of their catapult's build and strengthen and improve on their first attempts.
- Educators will stress that the cyclical process of design, create, test, and redesign is more important than attempting to achieve a working catapult on the first try.

BEFORE YOU VISIT

What are simple machines?	Devices that help multiply force, so the strength we exert goes much further. Levers, pulleys, and ramps are all examples of simple machines. Many complex machines build upon these basics.
What is potential energy?	Energy that is stored in some way. Think about stretched rubber bands, a pendulum held high, or a ball balanced on top of a hill. People also store chemical energy in batteries, but this workshop will focus on mechanical energy.
What is kinetic energy?	The energy of motion. All moving things have kinetic energy. Energy can change from potential to kinetic, and even back again.
What is drag?	A force that pushes back against motion. Think about the shapes of planes, missiles, or sports balls. They are built to decrease drag so objects go farther.

AFTER YOU VISIT

Questions

- Ask students to discuss the changes they made to their catapults during the workshop. What specific changes did they make? Why? Here is a good time to talk about vital changes (i.e., part of their catapult fell apart and required strengthening), versus improvements (i.e., the student wanted their projectile to go farther and made appropriate changes).

Activities

Students should have time during the workshop to refine their catapult design and compare with other students. But teachers can take this further.

- Teachers and students can compare and contrast the shape of the path projectiles take from different catapults.
    1. The length of the launch arm affects the projectile's path. What differences or similarities do students notice across designs?
    2. The amount of "kick" the catapult has depends on the student's choice of design. Which catapults seem to have the most power? Do they share any design details?
- With different or more materials, how can students design better projectiles? Students might cut shapes out of foam. Marshmallows and gummy candy might also be appropriate, but teachers should beware of hard objects that could be effective—but dangerous!—projectiles.

CAREERS THAT USE ENGINEERING

Carpenter: For people who like working with their hands, carpentry is a field with many different kinds of work. Carpenters might be responsible for creating and building furniture, like cabinets and tables. Or they might do the physical work of building a house.

Mechanical engineer: More highly technical than a carpenter, in many ways mechanical engineers use the same basic skills. Engineers spend their time figuring out how to design and build a machine or object to do a specific job. Mechanical engineers might design a new car motor, or build a skycrane to drop a robot on Mars.

Biomechanical engineer: If people seem more interesting than machines to some students, bioengineering might interest them. These engineers need to study biology and anatomy, but do not need to become doctors. They combine the science of living things with physics and mechanical engineering concepts to design and build medical devices, including prosthetic arms, legs, and hands.

Learn about **more careers** that use engineering!

MINNESOTA ACADEMIC STANDARDS FOR SCIENCE K-12

3.1.1.1.1 Provide evidence to support claims, other than saying "Everyone knows that," or "I just know," and question such reasons when given by others.

3.1.1.2.1 Generate questions that can be answered when scientific knowledge is combined with knowledge gained from one's own observations or investigations.

3.1.3.2.2 Recognize that the practice of science and/or engineering involves many different kinds of work and engages men and women of all ages and backgrounds.

4.1.2.2.2 Generate ideas and possible constraints for solving a problem through engineering design.

4.1.2.2.3 Test and evaluate solutions, considering advantages and disadvantages for the engineering solution, and communicate the results effectively.

5.2.2.1.1 Give examples of simple machines and demonstrate how they change the input and output of forces and motion.

5.2.2.1.2 Identify the force that starts something moving or changes its speed or direction of motion.

6.1.2.1.4 Explain the importance of learning from past failures, in order to inform future designs of similar products or systems.

6.1.2.2.1 Apply and document an engineering design process that includes identifying criteria and constraints, making representations, testing and evaluation, and refining the design as needed to construct a product or system to solve a problem.

6.1.3.1.1 Describe a system in terms of its subsystems and parts, as well as its inputs, processes and outputs.

6.2.2.2.2 Identify the forces acting on an object and describe how the sum of the forces affects the motion of the object.

6.2.3.2.1 Differentiate between kinetic and potential energy and analyze situations where kinetic energy is converted to potential energy and vice versa.