MAZE ENGINEERING (G3-6)

In this workshop, students will engineer a marble maze game to take home. The Works Museum's educators will provide a variety of materials students can choose from to craft their mazes, along with a few basic guidelines for building standards. Educators will also instruct and monitor students for safe tool use. Students will explore how the forces of gravity and friction help their marble maneuver through the maze. See p. 3 for standards this workshop supports.

SCIENCE CONCEPTS

No object moves, changes direction, or stops moving unless a **force** acts on it. There are two main forces at work in the type of maze games students will design: **gravity** and **friction**.

Gravity is a force that pulls objects down.

- Heavy things, like the Earth, pull other objects toward them.
- Gravity is always acting on us and the objects around us, even when think we can't feel it.
- Usually, items like the floor or a chair (or our own feet and legs!) keep us from falling down.
- If we remove the items holding us up, or drop a ball in the air or down a slope, gravity immediately pulls it down.

Friction is a force that slows or stops objects.

- Friction occurs when two surfaces rub or slide against each other.
- Friction works against an object's direction of motion. So, if an object is moving to the left, friction pushes to the right.
- Friction only exists when some other force starts acting first (like pushing with your hand or gravity's pull).

Educators will also stress the **Engineering Design Process** to students.

- There are many different ways to make a great maze.
- Students will have ample time to test their mazes with marbles.
- They will investigate how an object starts moving and changes direction through their maze, and strengthen and improve on their first building attempts.
- Educators will stress that the cyclical process of design, create, test, and redesign is more important than attempting to achieve an amazing maze game on the first try.

BEFORE YOU VISIT

How can you start an object like a ball moving?	Encourage students to be creative! They could push it with their hands or a tool. They could put it somewhere like a slope, slide, or in open air and let it fall. They could blow on it or shoot it (which are both kinds of pushing).
Why do objects stop moving?	Sliding or rolling objects usually stop moving because of friction in some way. When you brake your bike or a car, the brakes use friction to stop the wheels from turning. If you don't use brakes, the friction between the wheels and the pavement will stop it eventually. Even arrows and flying balls slow down because of a combination of gravity pulling them down and friction with the air slowing them down. However when we fall, we usually stop because the ground is pushing up as hard as gravity pulled us down. This is not friction.
What kinds of materials create lots of friction? What kinds create very little friction?	Ask students to think about how easy it is to roll or slide objects along different surfaces. Materials like carpet, sand, or grass have high friction. They push back when you try to slide things along them. Materials like ice, hardwood floors, or gym floors have low friction, and objects slide more easily.

AFTER YOU VISIT

Questions

- What kinds of materials worked best to add friction to your maze games?
- What makes a material have more friction? What are some common traits in materials with high friction?
- How is gravity working in your maze game, if at all? If not gravity, what force is making your object move?

Activities

Students should try playing each other's maze games.

- Most games have rules. Can students develop rules or point systems for their maze games that make them harder or more interesting?
- Are students using gravity only to move the marble through their game? How might their maze game change if they used a launcher to add more force to the object?

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. They 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.

Game engineer: Designing video games requires many different kinds of computer engineers, as well as engineers to think strategically and make games challenging yet fun. Some engineers design the idea behind the game to make sure levels and abilities stay interesting and balanced, while others build real-world physics into video game universes. Most types of game engineers require advanced computer coding knowledge, and they all follow engineering values of testing and experimenting.

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

MINNESOTA ACADEMIC STANDARDS FOR SCIENCE K-12

3.1.1.2.3 Maintain a record of observations, procedures and explanations, being careful to distinguish between actual observations and ideas about what was observed.

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.

5.2.2.1.3 Demonstrate that a greater force on an object can produce a greater change in 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