Grades 6–8

60 minutes

BUILD A PINBALL GAME

DESIGN CHALLENGE

Build a pinball game with a launcher and interesting obstacles.

SUPPLIES AND EQUIPMENT

Per whole group

- ☐ Several pairs of scissors to share
- ☐ Several rolls of masking and clear tape to share
- ☐ Rubber bands (100–200)
- ☐ Craft sticks (1 box of 300–1,000)
- ☐ Paper clips (1 box of 100)
- ☐ Brass fasteners (100–200)
- ☐ String
- ☐ Chipboard or cardstock
- ☐ Straws (100–200)

Per team

- ☐ Marbles (at least 1 per team)
- ☐ 1 shallow box (pizza box, shoebox lid, copier paper box lid, etc.)
- ☐ Optional: paper for planning

GETTING READY

Plan to get as many boxes as possible. Department stores recycle or discard empty shoeboxes; many will be willing to supply them for your activity.

In addition to the materials listed, you may also choose to provide additional craft supplies to inspire creativity. You may also want some pictures of pinball games to show those participants who have never played one.

MacGillivray Freeman's DREAM BIG

INTRODUCTION

Ask participants what they know about pinball games and if they have ever played one. Ask:

- What do all pinball games have in common?
- What causes the ball to move through a pinball game?

INSTRUCTIONS

Introduce the design challenge. In teams, participants will build their own pinball game that launches a ball and sends it through an obstacle course.

Divide participants into teams to plan their pinball games. Teams may design their pinball table on paper if desired. If participants are stuck, try asking questions to stimulate their thinking:

- How will you keep the game inclined/slanted?
- How will the ball be launched?
- What kind of obstacles will you include, and how many?

Instruct teams to build their pinball machine in stages, testing each stage as they go.

- The first stage is to design the launcher. Participants can use rubber bands or craft a lever to send the ball up the ramp into the main area of the game. Tell teams to include a curve at the top of the launch ramp to direct the ball to the obstacles.
- Next, tell teams to build their first obstacles at the top of the game and work their way down.

Have teams test their design and make adjustments as needed. They need to identify weak parts of their design and make improvements.

Evaluate the success of each design.

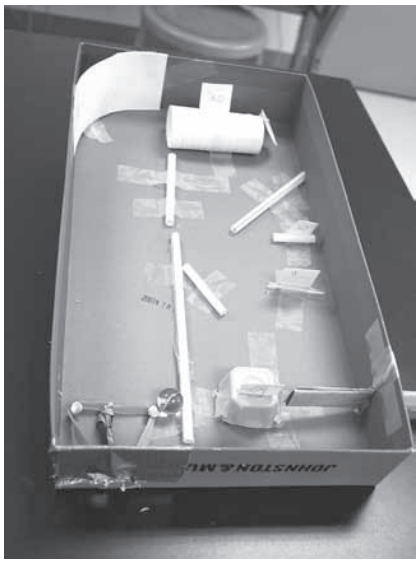
- ☐ Does the launcher send the ball all the way to the top of the game?
- ☐ Does the ball move through the obstacles without getting stuck?

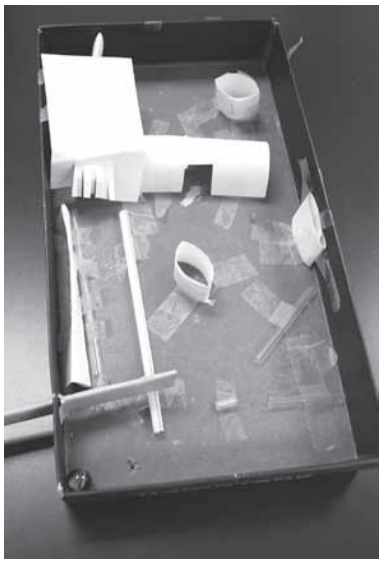
ACTIVITY VARIATIONS

For an easier version, skip the launcher and make it a maze game where the marble moves through the obstacles when the player tilts the board.

Increase the challenge by creating flippers.

Cut a few holes in different parts of the obstacle course, with holes being worth differing numbers of points.





TROUBLESHOOTING

- If the ball moves through the obstacles too quickly, teams should consider reducing the angle of the game.
- If the ball doesn't launch straight up, teams can design a guardrail to direct it to the obstacles.

RELEVANT TERMINOLOGY

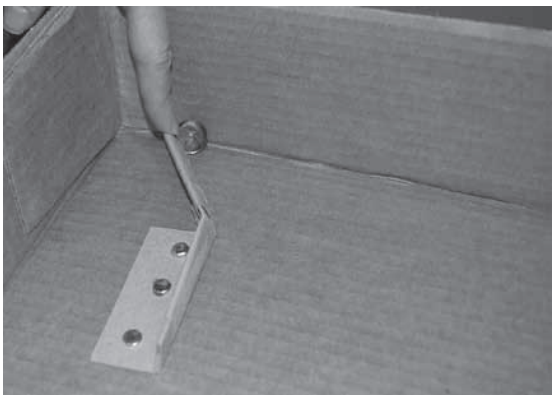
Inclined plane: A ramp, or a tilted flat surface; inclined planes are a type of simple machine used to push or pull a load.

Kinetic energy: Energy of motion. A marble moving through a pinball machine is using kinetic energy.

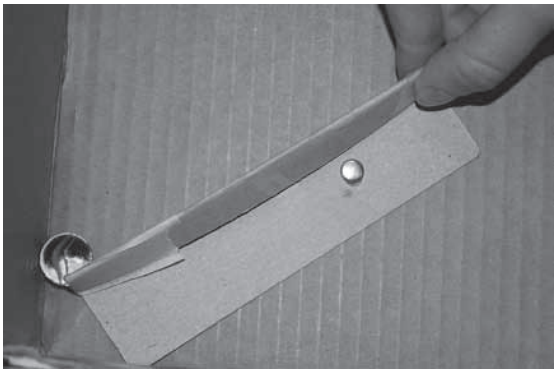
Lever: A bar that sits on a pivot, like a crowbar or a shovel. Sometimes used to move heavy objects.

Potential energy: Stored energy. A marble before it starts rolling has potential energy.

FIVE EXAMPLES OF MARBLE LAUNCHERS

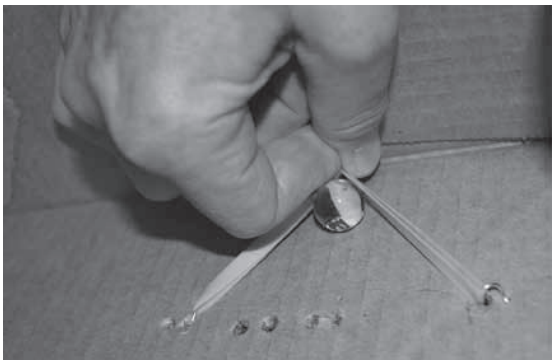


Spring: Bend back a fixed piece of cardboard. Let go to release the built-up tension.

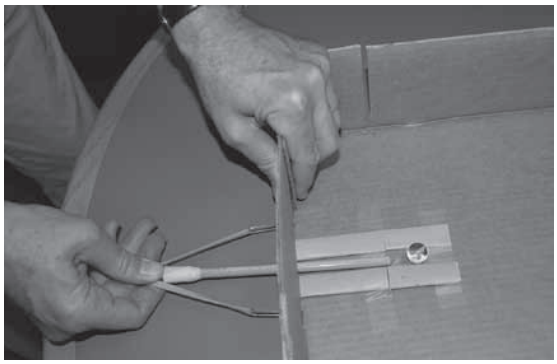


Lever #1: Make a pivoting launcher from folded cardboard and a brass fastener.

Lever #2: By inserting a piece of folded cardboard into a notch in the sidewall, kids can make a pivoting launcher or a flipper to keep the marble in play.



Slingshot: Secure the ends of a thick rubber band with paper clips and pull it back to launch a marble.



Striker: Use a rubber band–powered pencil to knock a waiting marble up the ramp.

GUIDANCE FOR YOUNGER CHILDREN

QUESTIONS TO ASK AFTER THE ACTIVITY

- Did your game work the way you wanted it to? If not, what changes would/did you make?
- How did you make the pinball move in your game?
- What materials did you use to make your game? Why did you choose those materials?
- Do you think your game was fun? How could you make people want to play your game again?

ENGINEERING CONNECTIONS

Pinball designers use the engineering design process to create great games. First, designers start with a problem—in this case, how to build a challenging and exciting game that will keep people coming back again and again to play. They research the problem to try to find the best solutions. They test their solutions using models, drawings, and prototypes. They also look at the successful games of other pinball designers. Finally, they decide which solution is best and then continue to refine that solution until it is perfect...or as perfect as they can make it.

SCIENCE CONNECTIONS

Designers have to think about a lot more than flashing lights and exciting sounds when they create a pinball game. A lot of scientific thinking goes into figuring out just how to get that pinball moving! Pinball designers know that to keep the ball moving requires a lot of pushes and pulls, called forces, which can change both the ball's speed and direction. The whole game starts with the launcher. This part is designed to push the ball with enough strength to move it all the way to the top of the game board, where gravity takes over. From there, it can be a challenge for players to keep the ball on the board.

GUIDANCE FOR OLDER YOUTH AND ADULTS

QUESTIONS TO ASK AFTER THE ACTIVITY

- What could you add to your game to entice people to play it? How could you guarantee they would come back to play your game again?
- How could the addition of electricity change your game? How would you use it to make your game better?
- If you designed flippers for your game, how could changing the shape, length, or fulcrum of them affect the movement of the ball?

ENGINEERING CONNECTIONS

The history of pinball machines highlights how pinball design uses engineering, because the pinball game itself has gone through many changes since it was first seen in the 1700s. Pinball actually started as an outdoor game, played much like croquet. Over the years it changed into an indoor game, until it was shrunk into a mobile tabletop game. Once it became smaller, many new components were added to enhance gameplay. For example, spring flippers were created to shoot the ball farther. The addition of a coin-operated feature was added so that the designers and builders of the games would be paid for their hard work in creating them. Electricity also added a level of excitement and enticement to encourage players to keep playing. Over the years, pinball designers have continued to find new ways to keep the game fresh and exciting. In a way, pinball designers are, through the use of engineering principles, constantly seeking the perfect pinball game.

SCIENCE CONNECTIONS

Pinball design requires a good understanding of the physics behind the game. The layout of each game table varies wildly, with different themes, obstacles, sounds, and lights, but all pinball game designs depend on two simple machines: the inclined plane, and the lever. The game board itself is an inclined plane that uses gravity to keep the ball moving ever downward into the traps at the bottom. The only hope players have to win is to keep the ball in motion using the flippers, which are levers made from various materials such as wood, metal, or plastic. The length of the lever and the location of the lever's fulcrum, or pivoting point, can affect the amount of force with which the lever hits the ball. The angle at which the ball hits and bounces off the flipper affects the direction of the ball's motion and, ultimately, determines whether the ball stays on the table or is lost into a trap.

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