Pinball Wizard

Two simple machines—a lever and an inclined plane—are the key to constructing a pinball machine out of a shoe box.

Prepare Ahead

- Try the activity yourself so you can anticipate where kids may get stuck or need guidance. Attaching the lever and positioning it so it works may be challenging for the youngest kids in your group.
- Collect shoe box tops and boxes. Cut the sides of the shoe boxes down to about two inches, so they look like the shoe box tops.
- Collect egg cartons.
- On the day of the activity, set up work spaces so each kid has scissors, pencil, shoe box top (or bottom with the sides trimmed), two egg carton cups, brass fastener, and a marble. Kids can share straws, cardboard, paper, and index cards.

Lead the Activity

Introduce Ruff’s challenge. (5 minutes)
Hand out activity sheets. Tell kids that today’s challenge is to make a pinball machine that shoots a marble to the top of the box and then leads it down again along an obstacle course. They’ll build it using a lever and several inclined planes.

- Review levers. If you did the previous activity, Action Figure, kids will be familiar with levers. If not, briefly discuss what they are, using the information in the Action Figure Leader Notes on p. 29.
- Introduce inclined planes. Tell kids that an inclined plane is a slanted surface. Ask them for examples (slides, wheelchair ramps, staircases, ladder, slanted roof). Ask why an inclined plane might be useful (it makes it easier to raise or lower things).

Materials

- activity sheet for each kid
- shoe box tops or boxes—see “Prepare Ahead” (1 per kid)
- utility knife (to cut boxes)
- clear tape (1 roll per 2 kids)
- scissors (1 per kid)
- egg cartons (2 cups per kid)
- straws (several per kid)
- brass fasteners (½” or ¾”)
- thin cardboard
- construction paper or index cards
- marbles (1 or 2 per kid)
- pencil (1 per kid)
- optional: paper cups, bottle caps, pipe cleaners, markers, aluminum foil, or other odds and ends.

National Science Education Standards

Grades K–4
Physical Science: properties of objects and materials; position and motion of objects
Science and Technology: abilities of technological design

Grades 5–8
Physical Science: properties and changes of properties in matter; motions and forces
Science and Technology: abilities of technological design
Build the basics. (15 minutes) Hand out the activity sheets and have kids follow steps 1–5. Emphasize that they should test after every step, making sure their marble does what they want it to do. Kids may need help with:

- Making holes in the cardboard lever and through the bottom of the box.
- Positioning the lever so it shoots the marble easily, and doesn’t hit the side of the box. If the lever doesn’t move easily, kids can try loosening the brass fastener a little.
- You may need to demonstrate how to flick the lever. Have kids practice shooting the marble.

Get creative. (15 minutes) Steps 6 and 7 on the activity sheet are open-ended steps that encourage kids to be inventive. Supply paper cups, pipe cleaners, bottle caps, markers, and other items to stimulate their ideas.

Discuss what happened. (5 minutes) Gather as a group, and have kids display their pinball machines and try out other kids’ models. Ask them to point out any unusual or especially creative features.

Award points. (5 minutes) Time to rack up some points! Review the activity’s key ideas by asking the following questions, worth 50 points each.

1. What makes your pinball machine work? (Inclined planes and a lever; gravity)
2. What would happen if your pinball machine wasn’t propped up on the egg carton cups? (The marble might wander in any direction.)
3. How many inclined planes are on this pinball machine? Choose one of the kids’ models as an example. (Be sure kids count the pinball machine itself as an inclined plane.)
4. Name some examples of inclined planes. (Answers may vary.)
5. What kinds of changes would you make to your design if you had more time, a bigger box top, or different materials? (Answers may vary.)
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Make a pinball machine that can shoot a marble and send it zigzagging down an obstacle course.

1 Get what you need.
- shoe box top • clear tape • scissors • 2 cups from an egg carton • straws • brass fastener (½” or ¾”) • thin cardboard • marble • pencil
- optional: small paper cups, bottle caps, pipe cleaners, markers, aluminum foil, odds & ends

2 Tilt the box. Tape two egg carton cups to the bottom of one end of the box. This creates an inclined plane (a slanted surface) when turned right side up.

3 Design a lever.
- Fold a 2-inch-long strip of cardboard in half lengthwise to make a lever.
- Position it in the lower-left corner of the box, as shown, so that the lever can shoot the marble.
- Attach it to the box with a brass fastener, poking a hole in both the lever and the box with a pencil.
- Flick the lever with your finger to test if it can shoot the marble. If necessary, shorten your lever or reposition it until it works.

4 Make a path. As shown, tape down a straw to lead your marble to the top of the box.

5 Add a curve. In the top left hand corner, tape a piece of paper to create a curve so your marble rolls smoothly to the right. Test and redesign until it works.

6 Build an obstacle course. Lead your marble to the bottom of the box by taping pieces of straw at different angles (these are inclined planes). Work from the top to bottom, testing as you go.

7 Get creative. Add curves, arches, or tunnels using cups, paper, tin foil, and anything else you can think of!

Chew on This
Your pinball machine was built using two kinds of simple machines: a lever and an inclined plane. The lever shot the marble to the top of the box with lots of force. The inclined planes made the marble wind its way down to the bottom.

Did you notice how much testing it took to get your pinball machine to work the way you wanted it to? Testing and experimenting are a big part of being a scientist and engineer—that’s how brilliant solutions and great discoveries happen!
**Dig Deeper**

**Take it outside.** Make another pinball machine, this time using materials from nature to construct the obstacle course (rocks, twigs, leaves, etc.). Build a nature trail for your marble!

**Magical marble tour.** Send a marble on a long, crazy journey! Place some books under two legs of a table so that the surface is tilted. Your goal is to make a winding maze that leads the marble from the highest to the lowest point. Use books, cardboard, paper towel tubes, straws, paper cups, and tape.

**Did You Know?**

Pinball machines are mechanical wonders that launch a steel ball on a wild ride around a colorful table full of flashing lights, bells, buzzers, and flippers. The golden age of the pinball machine was in the 1950s and 1960s. Kids used to play them in penny arcades and amusement parks. But once video games became popular, pinball machines became an endangered species. Today, only one company still makes them.

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The FETCH 3000, my trusty computer, just crashed! I can’t run the show without it! Even worse, I can’t play video games without it! What’s a high tech hound gotta do for a little fun around here? Hmmm . . . I’ve heard about an ancient game people played before we had computers—a pinball machine. Build one, and let’s find out what this primitive contraption can do!