Western Engineering Outreach

Create a pinball machine

Grade 6-8

Meet Today's ENG HERO!

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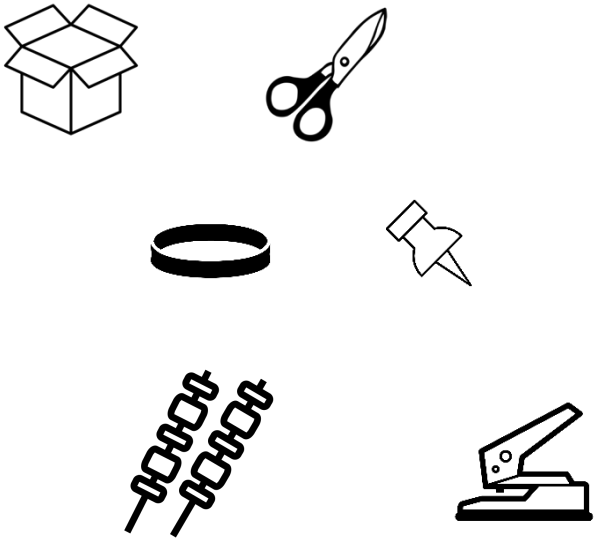
Hamid Abdolvand is a faculty member of Mechanical and Materials Engineering Department. His research focuses on deformation and failure mechanisms of engineering materials across length and time scales. Before joining Western Engineering, he was a postdoc researcher at the University of Oxford were he spent 3 years working on electron and synchrotron x-ray diffraction analysis of engineering materials. Prior to Oxford, he worked at the University of Manchester, developing finite element codes for Rolls-Royce Plc an AMEX-Europe. *To learn more about Dr. Abdolvand visit:* https://www.eng.uwo.ca/mechanical/faculty/abdolvand_h/index.html

Learning Goal:

- Students will investigate the elements that cause movement.
- Curriculum Connections: Grade 7 -Form and Function, Grade 8- Systems in Actions

Materials Needed:

- Cardboard
- Skewers
- Hot glue gun
- Scissors and safety knife
- Marbles
- Rubber bands
- Popsicle Sticks
- Hole puncher or a screwdriver
- Push pins
- A Pencil
- 2 Clothespins



CREATE A PINBALL MACHINE

Engineering and Science Connections:

Today, we will investigate the elements that cause movement and how things work together to create a mechanism.

What is Energy?

- Energy is the ability to do work. It is how things change and move.
- The Law of Conservation of Energy states that energy can neither be created nor destroyed. If you think energy has 'disappeared', it has not. Energy is transformed from one form to another when it is conserved.
- All mechanical energy is classified as either kinetic or potential.
- Kinetic energy is the energy of motion and potential energy is stored energy

What is a Lever?

- A lever is a simple machine that makes work easier for use by decreasing the force required to do work.
- Levers involve moving a load around a pivot using effort.
- A bell crank is a lever with two arms that have a common pivot at their junction.
- The bell crank on your pinball machine transfer horizontal force to vertical force

What is Force?

- Force is a push or pull on an object which changes direction of speed of motion.
- The flipper in the pinball machine changes the marble's speed and direction of motion.
- The force of gravity accelerates the ball down the incline of the pinball machine.

What is Work?

- Work is the amount of force needed to move an object a certain distance
- The flipper transfers energy to the ball to keep the ball in motion.

Video Recommendation: *Pinball Machine*

https://www.youtube.com/watch?v=gnrrbKFWL3Q

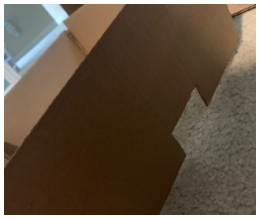
Activity:

Before beginning, think about the following questions:

- What is Kinetic Energy?
- What is Potential Energy?
- Can Energy be created?
- What is an example of a machine used to carry heavy things?

CREATE A PINBALL MACHINE

Part 1: The Base


1. Choose a size for your pinball machine, make the boarders and the bottom (looks like a box with an open top)
2. Cut a square in the side that you want to be the front side.
3. Cut 2 long triangles to make a slope for the marble to slide back down after the launch, and glue them to the sides.
4. Cut another piece of cardboard to fit inside your box, and glue it in to be placed on top of the 2 slanted triangles.


Part 2: The Flipper (paddles)



1. Choose the shape of your paddles (trapezoids are easier to cut).
2. Cut 8-10 of that shape, and glue 4-5 on top of each other twice to make 2 paddles.
3. Using a screwdriver, poke a hole through all of the layers except one (the top layer).
4. Cut 8 rectangles, glue 4 on top of each other (x2) and poke a hole through all the layers. Set aside.
5. Glue a piece of a skewer in the holes you poked in the trapezoidal paddles.

6. Poke 2 holes in the base of your box, and insert the 2 skewers attached to the paddles through the 2 holes.
   * The paddles should align with the square you cut in the front of the box in Part 1.
7. Flip your box and find where the skewers attached to the paddles are coming through.

8. Take the 2 rectangular pieces you glued together in step 4, and insert them onto the skewers.

9. Poke holes on the other side of the rectangles, opposite the skewers.
10. Cut 8-10 pieces of the shape shown below. And insert a popsicle stick once they are all glued together.

11. Poke a hole on the rounded side.
12. Using another 2 small pieces of skewers, glue the skewer in the 2 holes from steps 11, and step 9. Now the rectangles should be attached the two rounded pieces.

Part 3: Launcher

13. Cut another small hole in the corner of the front side of the box (for the marble to be launched from there).
14. Using cardboard, make a mini box as shown on the right and glue it in front of the hole you just made.
15. Grap 2 clothespins, put a rubber band in between both and glue the clothespins to the sides of the mini box.

Part 4: Final Touches

16. Make a semi-circular boarder for the marble to not be stuck anywhere around the box.
17. Now add obstacles in the middles to make it challenging.
    * You can use push pins with rubber bands stretched between them to bounce around. The marble around.
18. Use the popsicle sticks to move the paddles.
19. To launch, place a marble between the clothes pins, pull the rubber band down, and release.

What Did You Learn?

- How are work and kinetic energy of a moving object related?
- How do machines use energy to do work?
- What is Mechanical Energy?
- What are the two forms of Mechanical energy?
- How does a hinge work and why is it beneficial?

Future Learning

- Once you are done building your pinball machine, go look for other objects around your house to add as obstacles. Does the marble get stuck when going down? How can you overcome the force of friction that makes the marbles stop?

Share your creations!

We would love to see what you made. Email as at discover@uwo.ca or tag us on social media.

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Thanks for discovering with us!