Perpetual Motion

Objective: Students will create and explain Heron's fountain as an example of a fluid powered machine.

IMPOSSIBLE SCIENCE

Materials:

- Two 14 inch different colored tubes
- One tube around 10 inches long (or a few inches longer than the bottles)
- 3 plastic bottles with caps- about half the size of the longer tubes
- Silicone
- Drill
- Drill bit that is the same diameter as the tube

Optional Materials:

- A variety of fluid powered devices or pictures of them such as: adjustable height desk chair, air pump for a ball, syringe, drill, toy bulldozer, or fire extinguisher.

Set Up

Lay out materials at each workstation.

Create a diagram of Heron's fountain similar to the one in the video and display it for students to reference.

Hook

1. Sit in front of the class on an adjustable height desk chair. Raise the chair up and down, pump up a ball using an air pump. Surround yourself with other examples of fluid powered devices (or pictures of them).
2. Ask: What do these items all have in common?
3. Assign a device (can be a picture of a device) to each group, and ask them to brainstorm an explanation of how it might be powered.

4. Share answers, then explain that they all use fluid power, which is described as either hydraulic (using liquid), or pneumatic (using gas) under pressure to create power.

Procedure

1. Explain that the Law of Conservation of Energy states that energy cannot be created or destroyed, it can only be transformed or transferred.
2. Show Impossible Science video to 2:23, then pause to give students time to copy down vocabulary.
3. Ask students how the fountain might work, challenging them to incorporate new vocabulary.

Vocabulary

Law of Conservation of Energy: Energy can't be created or destroyed, it can only be transformed or transferred.

Fluid power: The use of a liquid (hydraulic) or gas (pneumatic) under pressure to generate, control, and transfer power.

Gravitational Potential Energy: The amount of energy stored in an object as the result of its vertical position or height.

Heron's Fountain: Created by inventor, mathematician, and physicist, Heron of Alexandria (10-70 CE), it demonstrates how potential energy can create power using water, air, compression, and gravity.

Bhaskara: A Hindu mathematician from the 1100s who decided to build a perpetual motion machine using only weights and wheels.

4. Explain that the water in the top container contains gravitational potential energy and it moves from high to low gravitational potential energy as it falls, creating pressure that makes the fountain form due to pneumatic pressure in the straw.
5. Show the remainder of the video and pause at each step for students to follow along and create their fountain.

Heron's Fountain Instructions

Note: The first six steps can be completed in advance, as the glue takes up to an hour to dry.

1. Lay bottles on their sides with caps touching and make a mark connecting the caps.
2. Remove caps from plastic bottles.
3. Apply silicone to the tops of the caps and glue them together.
4. Flip one bottle over and fill the bottom with silicone.
5. Glue the third cap into the silicone bottom.
6. Wait an hour for them to dry.
7. Drill two holes into the caps, making sure to leave space between the holes.
8. Insert one 14 inch tube into the bottle, stopping at the single cap.
9. Thread the glued caps over the tube.
10. Insert the shorter tube through the second hole in the glued together caps until it reaches the cap of the other bottle.
11. Screw the second water bottle onto the cap, sealing it tightly.
12. Add silicone between caps to ensure they are airtight.
13. Insert a second 14 inch straw into the cap at the bottom of Chamber B.
14. Cut the bottom off of the last water bottle, flip it upside down, and screw it into the bottom of Chamber B

15. Add a bottle of water to the top and wait for it to end up in the bottom of Chamber C.

16. Flip the fountain upside down, and wait for the water to go back into Chamber B.

17. Once all the water is in Chamber B, flip it back over and add a little water to the Chamber A to start the fountain.

Assessment:

Students should respond to the following questions:

1. Is Heron's Fountain a perpetual motion machine? Why or why not?
2. What type of power does it use? How can you tell?
3. How is energy transferred in the fountain? What will cause it to stop?

Safety Notes:

Adult Supervision Recommended

Watch the companion video here:

YouTube