

611-2250 (30-040) Hero's Fountain

Introduction: The first century physicist, mathematician and inventor Heron, also known as Hero of Alexandria, is responsible for creating the world's first artificial, stand alone fountain that required no energy input. Previous fountains had been built using hills to generate the necessary pressure, but Hero's was unique because it could be placed on a tabletop, and also was completely vertical in design. It used a system of tubes and airtight chambers to make a fountain that was powered entirely by gravity. Some have called it the first perpetual motion machine. This is a misnomer because the fountain will eventually stop running.

Heron also invented many other devices, including the world's first steam engine, automatic instrument, and vending machine.

Description: our version of Hero's fountain is made entirely of glass. Early examples were opaque to fool the viewer, but ours is transparent to allow your students to observe the principles at work. It consists of an open pan, a spherical glass chamber with a long neck, and an Erlenmeyer flask. Stoppers are placed at all openings to make the chambers airtight, and a system of tubes runs the length of the apparatus. These tubes are the heart of the device and allow it to function.



Figure 1

Warning: The entire structure is glass, be careful. Do not place the fountain near the edge of a table or any other position where it could break.

Operation: to use, fill the central bulb and the lower flask half way with water (See figure 1). The stoppers are not sealed in position and can be removed for this task. If you prefer, you can use a syringe or pipette to fill the chambers directly through the tubes. Colored water will make the display much more visible.

Once the chambers are half full, reassemble the fountain. Take care that the stoppers are in place, forming an airtight seal with the chambers. It is possible to slide the stopper up and down the tubes, making the set fully adjustable.

You may wish to place the fountain in a pan or tray in case of accidental spillage. Place the included pipette tip on the taller of the two tubes in the top section of the fountain. Pour water into the upper pan, and watch as water fountains out of the upper tube (See figure 2). The pipette tip is not required, but it helps generate higher pressure, making the fountain reach higher.

Explanation: to the untrained eye, Hero's fountain has all the appearances of a perpetual motion machine. The water from the pan is released at a higher point, which falls into the pan again. It seems like this process should continue forever. Obviously, this is impossible. What is going on?

Remember that no external power is being applied to the system. This means that the



Figure 2

fountain is operated by gravity alone. Now, gravity can attract water downwards, but cannot shoot it up. To explain this, examine the system of tubes and keep the gas laws in mind.

As water travels from the top pan into the lower bulb, it gains speed. When it enters the bottom flask, it rushes in, displacing the air inside. This air compresses, increasing the pressure and forcing its way into the central bulb. Here, the air is compressed further as it mixes with the air already in place. This high-pressure air is enough to force some of the water from the central bulb up through the fountain tube, causing the display.

The system works because water is flowing downwards more than it is flowing upwards. It is the water from the central bulb that feeds the fountain, and the lower bulb that supplies the compressed air. Thus, the final movement of the water is down. When the lower bulb has been filled beyond a certain point, it no longer can produce enough compressed air to power the fountain. A well designed fountain with a large lower bulb and more chambers might play for hours, but even the best one will ultimately stop.

Warranty and Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Not designed for children under 13 years of age.

Other Science First Products:

611-2375 Water Hammer: The water hammer is a great demonstration of properties of a vacuum. Show how a liquid can act like a solid. Pull the water hammer down about 15cm and you will hear a "clink" sound like a hammer hitting a nail on the head.

611-2335 Collapsing Can Demo: This collapsing metal can makes a good introduction to air pressure for any age student. The can, when evacuated by a hand pump, will crumple right before your eyes. You can also boil a small amount of water inside to drive out all the air, then cap it and let it cool. Includes one sturdy metal can, rubber stopper with hose nipple to evacuate can, and screw cap. 23 x 17 x 10 cm in size.

611-2270 Diving Bell: Underwater exploration has fascinated us since we first started sailing the seas. The diving bell in one form or another has allowed us to breathe under water. Used by such notables as Alexander the Great, Bernoulli and Pascal, it is essentially a submerged container filled with air, the air pressure holding the water at bay. Our simplified demo contains a bell, syringe, connecting tube and instructions. First draw the air out with the syringe; then place the ball in water and watch it sink. When you inject air slowly back into the ball, it rises.

611-2220 Lift Pump: Demonstrate how a well pump works! Our 300 x 150 x 200 mm lift pump works by drawing water from its lower basin. As the bottom half of the piston chamber gets filled, it causes water to flow out of the spout.