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Low-Cost Competition

Apparatus Title: **Hero's Fountain**

Abstract:

Hero's fountain is dramatic and one of the best demonstration of the topic "Liquids". A new simply constructed, easy-to-make demonstration of the Hero's fountain is presented. Its action is discussed on the basis of Pascal's and Bernoulli's principles.

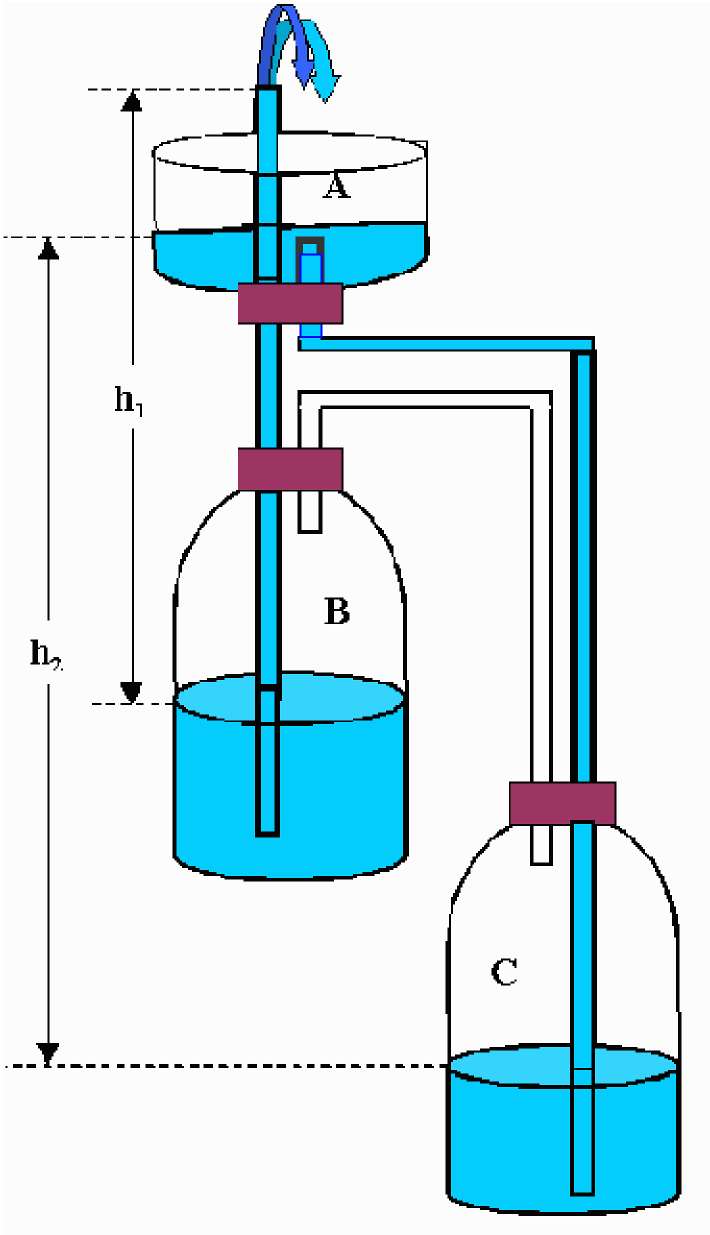
Equipment required to construct apparatus: To make the magic fountain you need three 2-liter plastic soda bottles, three rubber stoppers #3 with two ¼ " (0.006 m) holes each, two pieces of plastic tubing about 2½' (0.8 m) long and ¼ " glass tube about 3' (1 m) long.

Item Source/Store Part Number Cost

Total cost: less then $10

Description

Figure 1 incorporates a schematic drawing for Hero's fountain. The fountain consists of three parts: a cup A with the fountain tube, and two vessels B and C. The parts are connected as shown in Figure 1. The vessel B is filled with water and the vessel C is empty. Cup A is placed on the vessel B and connected with the vessel C by a hose. Vessel B with the cup can be placed on a table and the other one under the table. When you pour water into the cup A, the water from the cup flows to the lower vessel C, which contains air, and produces the hydrostatic pressure P2 = rho g h2, additional to the initial atmospheric pressure Patm, of the air in the vessel C. As a result the pressure forces air up to the upper vessel and according to the Pascal's Principle the air transmits this pressure to the water in the upper vessel B. The pressure that air exerts on the water in the vessel B, oppose the atmospheric pressure and the hydrostatic pressure P1 = rho g h1 . Thus, the compressed air in the vessels B and C forces the water to spout out of the fountain's upper tube and drives the fountain.



Hero's fountain is also a good demonstration for Bernoulli's principle. Let us consider again the fluid as an ideal, and determine the speed of the ejected water from the nozzle of the fountain. Use the Bernoulli's principle at the top of the water in the vessel B and the nozzle. The vertical motion of the top of the water in the vessel B is an insignificant. Therefore, the vertical speed of the water at the top in the vessel B is negligible compared with the speed v of the emerging stream of water from the nozzle of the fountain and Bernoulli's equation becomes

$$P_{atm} + \rho g h_1 + \frac{\rho v^2}{2} = P_{atm} + \rho g h_2 . \qquad (1)$$

Solving equation (1) for v, we find

$$v = \sqrt{2g\,(h_2 - h_1)}. \qquad (2)$$

Thus, by moving the vessel C up and down we can change the pressure of the air on the surface of the water in the vessel B and as a result, the speed of the water from the nozzle of the fountain will change. When the air pressure increases (vessel C moves down and as a result the difference of heights $h_2 - h_1$ increases), the speed of the ejected water increases and the water rises higher with respect to the nozzle and vice-versa. In real-life fluids the effects due to the viscosity are significant and the speed of the ejected water will be smaller than that given by equation (2). If we neglect the viscosity of the water the height of the emerging jet above the nozzle would be equal to the difference in heights $h_2 - h_1$.