Name(s)
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Project Number
38421

Project Title
Exploring an Ancient Wonder: Understanding the Difference in Height, Viscosity and Tube Diameter Has on a Siphon

Abstract

Objectives/Goals
The goal of my project was to find how the difference of height, tube diameter, and viscosity has affects flow rate of a siphon. I hypothesized that thinner tubes and higher viscosity would have slower flow rates and that rung height would not change the flow rate. I used my new understanding of a siphon to prototype a perpetual siphon sink.

Methods/Materials
My project explores the effect that tube diameter and viscosity of a liquid have on a siphon at different heights. Viscosity variables were water, acetone, and canola oil. 5 different tube diameters (0.4cm, 0.6cm, 0.8cm, 1.2cm, 2.5cm) and 3 different rung heights (87cm, 116cm, 145cm) using a ladder were tested. Tube length and temperature were constant. Testing sequence was as follows: 1. fill the tube with the liquid, 2. manually seal both ends of the tube, 3. rest tube over rung, 4. simultaneously release seals while starting the timer, 5. stop timer when bubbles first enter tube and record time. Flow rate was calculated as volume per time (mL/sec) and graphing performed in Google Sheets.

Results
90 trials were performed by 45 different combinations of variables. Flow rate increased exponentially with increase in diameter, in some trials approximating radius4. All of the canola oil trials proved to be the slowest flow rate of all the viscosities when compared to water and acetone. Rung heights variable effect on flow rate for all three liquids and tube diameters. There was no distinct relationship with flow rate and rung height.

Conclusions/Discussion
As predicted, liquids with higher viscosities had lower flow rates. Fluids with higher viscosities have more internal friction and more resistance to flow. Also, as Poiseuille#s law predicts, tubes with larger diameters had an exponentially higher flow rate. With bigger tube diameters, there is more space in between the walls of the tube and this reduces friction and encourages laminar flow within the tube. Increasing rung height had an unpredictable effect on the siphon flow rate. I predicted that the flow rate would be the same with increasing heights because the more uphill the tube has the more downhill it will have to balance the forces out and the more potential energy at the top of the siphon. I used this understanding of flow characteristics to design a perpetual siphon sink.

Summary Statement
Tube diameter and liquid viscosity predict flow rate through a siphon with greater accuracy than maximum height

Help Received
In order to start the large diameter siphons, I needed an assistant to seal the opposite end of the tube with their hand.