Experiment A1
Meter Stick Measurements
Procedure

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Deliverables: Checked lab notebook, Full lab report (including next weeks data, due in two weeks)

Overview

In this lab, you and your lab partner will each be given an official AME 20216 meter stick. The meter stick is the most basic scientific instrument, and you will use it to measure some physical properties of the Notre Dame campus. First, you will use it to measure the height of the water tower on the north end of campus and calculate the pressure at its base. Then, you will use it to measure the exit velocity of a parabolic fountain jet. The overall goal of this lab is to illustrate the basic concept of a "transducer" and show that a bit of ingenuity can greatly simplify a seemingly impossible measurement.

Part I: Height of the Water Tower

1. Use one or both of the meter sticks to measure the height of either the Water Tower on the north end of campus by applying the concept of *similar triangles*. (Do not climb any buildings or fences!)
2. Sketch a schematic of your experimental method and record your measured values in your lab notebook.
3. Calculate the hydrostatic pressure in units of Pa at the base of the water tower.
4. Do a bit of online research to determine the actual height of the structure.

Part II: Fountain of Youth

In this exercise, you will use your meter stick to determine the velocity of a jet of water as it leaves the nozzle of a fountain.

1. Find a fountain on campus with a jet that makes a nice parabolic arc.
2. Measure the dimensions of the parabolic arc use them to calculate the initial velocity components v_x and v_y of the water as it exits the nozzle.
3. Use Bernoulli's law to estimate the stagnation pressure inside the nozzle in units of Pascal

$$P_0 = \frac{1}{2}\rho\left(v_{x0}^2 + v_{y0}^2\right) \qquad (1)$$

   where ρ is the density of water.
4. Record the location and sketch the arc with dimensions in your lab notebook.
5. Take several photos of the arc to illustrate its parabolic shape.

Deliverables – Download the LaTeX or MS Word template from the course website and use it to write a lab report, **no longer than 7 pages**. You are required to include the following items in your lab report. There will also be additional items from next week's A2 lab. (See the A1/A2 score sheet for points.)

1. The height of the water tower you measured compared to the actual value. (Be sure to include a citation for the actual value.)

2. Based on the height you measured, calculate the hydrostatic pressure at the base of the water tower in units of Pa. Be sure to include the equation you used (i.e. Eq. (1) of this handout).

3. A simple schematic illustrating the technique you used to measure the height of the water tower. The drawing must be produced using computer software. (i.e. Power Point, Adobe Illustrator, Photoshop, etc.)

4. A photograph of the parabolic fountain jet you measured with the dimensions superimposed over it in *symbolic form*. (i.e. use variables like R and H.)

5. Equations that you derived for the initial velocity components v_{x0} and v_{y0} in terms of the jet's dimensions.

6. Values for the initial velocity components v_{x0} and v_{y0} in units of m/s.

7. An estimate of the stagnation pressure inside the pipe of the fountain.

8. A table summarizing all of the values you reported.

Suggested Talking Points

- How does the height of the water tower you measured compare with the actual value? If it does not agree, discuss potential ways to improve your measurement technique.

- The hydrostatic pressure of the water tower drives the flow of the fountain jet and all other water sources on campus. How does the stagnation pressure of the fountain compare to the hydrostatic pressure you calculate for the tower? Why might they be different?

Appendix A

Equipment

- Smart phone
- Laptop computer
- 200 foot tape measure
- Official AME20216 meter stick (Yours to keep!)