

# 2.6 Water Town Introduction and Design of Experiments

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## Summary

Students begin their main project in Civil Engineering to design a water distribution network, or Water Town. Students will perform a design of experiments to understand how things like water tower height and pipe length, diameter, and fittings affect the flow rate through the piping.

## Learning Objectives

After this class, students will be able to:

- Explain how water tower height, pipe diameter, pipe length, and pipe fittings affect fluid flow.

## Materials

Each student team will need the following (parts may need to be improvised based on local availability):

- $\frac{1}{2}$  gallon juice bottle with drilled out lid (using  $\frac{3}{4}$  in. spade bit with very light pressure during drilling) for water tower
- (2) Hose washers
- $\frac{1}{2}$  in. Threaded Flex pipe adapter
- $\frac{1}{2}$  in. PVC ball valve, common threaded
- $\frac{1}{2}$  in. PVC coupler, (female slip to male threaded)
- 10 ft. of  $\frac{1}{2}$  in. Polyethylene flexible tubing (black irrigation tubing)
- 3 ft. of  $\frac{1}{4}$  in. Polyethylene flexible tubing (black irrigation tubing)
- $\frac{1}{4}$  in. 90 degree elbow fitting for Polyethylene flexible tubing
- $\frac{1}{4}$  in. coupler for Polyethylene flexible tubing
- At least 48 in. of 1 x 2 in. board
- Fluid Flow Design of Experiments worksheet

Other equipment needed in the lab:

- PVC pipe cement
- Teflon tape
- $\frac{3}{4}$  in. spade bit
- Hammer
- Utility knife
- Table vice for holding board to which the water tower bottle is attached or other method for holding water tower at desired height
- Duct tape

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- Tape measure
- Drip irrigation hole punch tool
- Graduated cylinders (500 ml or 1 L)
- Stop watch or other timing device

## Time

80 minutes

## Procedure/Pacing

1. Have students read the instructions on the Fluid Flow Design of Experiments worksheet.
2. Ask students “Why will we be doing this design of experiments?” Answer should be similar to “To understand how pipe diameter, pipe length, water tower height, and fittings affect the flow of water through the pipe.” Help students realize that this understanding will help them properly design their water distribution system.
3. Ask “What variables will we be changing in this experiment?” Answer “Water tower height, tubing diameter ( $\frac{1}{2}$ ” and  $\frac{1}{4}$ ”), tubing length, the effect of fittings.”
4. Ask “What will we be measuring?” Answer “Water flow rate”
5. Ask “How can we measure flow rate?” If students are not able to answer, ask them to define what flow rate is. (Flow rate is volume of fluid per time.) Answer “Time how long it takes to fill a determined volume or record how the volume filled in a determined time. Then divide volume by time to calculate flow rate.”
6. Allow students to work through the worksheet, performing their design of experiments, for the remainder of the period.
7. Each student should answer the questions in the worksheet, record the data and graph the data in his or her notebook.

## In-Class Assignment

Assignment 2.6i: Fluid Flow Design of Experiments Worksheet

## Resources

Sprinkler Line Assembly:

- <http://youtu.be/lwKcMSDXHig>

Water Towers:

- <http://people.howstuffworks.com/water.htm>
- <http://wonderopolis.org/wonder/how-do-water-towers-work/>

Water Distribution Networks:

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- [http://www.who.int/water\\_sanitation\\_health/dwq/en/piped3.pdf](http://www.who.int/water_sanitation_health/dwq/en/piped3.pdf)  
[http://www.samsamwater.com/library/TP40\\_21\\_Water\\_distribution.pdf](http://www.samsamwater.com/library/TP40_21_Water_distribution.pdf)

## **Homework**

Assignment 2.7h: Water Town Construction and Measurements

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