Worksheet: How fast does water empty from a tank

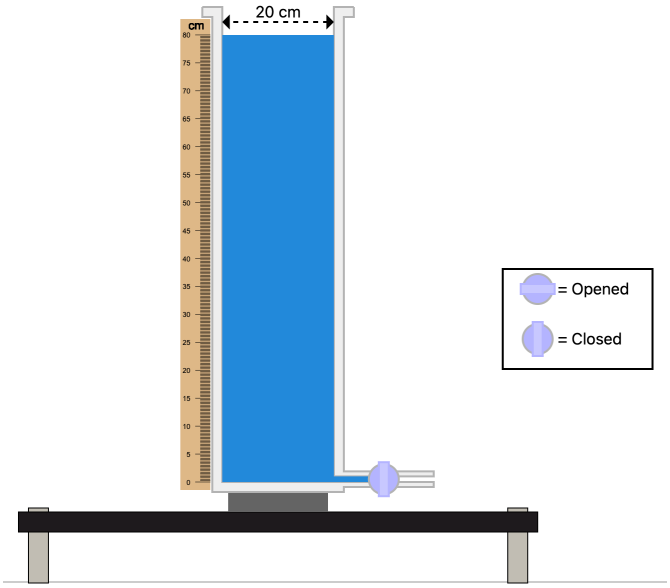
Name(s):_____

Fill in all sections – These are today's notes

Student Learning Objectives

1. Use the continuity equation and mechanical energy balance to predict velocity in a tank
2. Use differential equations to predict height vs time in a tank
3. Demonstrate how tank height and drain diameter impact the change in height versus time

Schematic and Dimensions



Before running the experiment:

1. Imagine you turn on the valve and the water starts to flow out, *where* (top of the tank, middle of the tank, bottom of the tank, drain) would the velocity be maximum? Why?

2. Imagine you turn on the valve and the water starts to flow out, *when* (just after turning the valve, middle of the drain time, end of the drain time) would the velocity be maximum? Why?

3. If tank starts with half the height of water, do you expect it to drain in less than half the time / half the time / more than half the time? Why?

4. If drain diameter is reduced, would you expect the water to drain slower / at the same rate / faster? Why?

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Running the experiment:

1. Set the water tank height to be 80 cm, drain diameter to be 1 cm and collect the data of water height versus time.
2. Set the water tank height to be 40 cm, drain diameter to be 1 cm and collect the data of water height versus time.
3. Set the water tank height to be 80 cm, drain diameter to be 0.5 cm and collect the data of water height versus time.
4. Set the water tank height to be 40 cm, drain diameter to be 0.5 cm and collect the data of water height versus time.

Plot all the values on a single plot of height versus time. What do you notice?

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After the experiment:

1. Use continuity and Bernoulli's equation to predict velocity in the tank for a tank height "h", diameter of tank "D" and drain diameter "d".

2. Assuming velocity in the tank is equal to "-dh/dt", solve the differential equation for h(t), assuming the initial height is "H".

3. Plot the predicted trends on top of the experimental collected data. What did you conclude?