Water-Flow Lab - Chapter 7

In this experiment you will fill a cylinder with water and allow the water to flow out of a small hole near the bottom. The point of this experiment is to explore the relationship between the volume of water that flows out of the hole and the elapsed time.

Materials

You will need at least three people (2 groups can work together to get the data) and the following items:

1. a timing device, a tape measure or ruler, and a marker
2. a transparent cylinder with a closed bottom. Near the bottom, there should be a hole that is large enough so that water flows out rather than drips out. The cylinder should be large enough and the hole small enough so that it takes at least a minute for the full cylinder to drain. For example, a cylinder that is 4 feet long with a diameter of 3 inches works well with a hole that has a diameter of about $\frac{1}{8}$ inch.
3. a bucket to catch the water that flows out of the cylinder

Preparation

Make about eight equally spaced marks along the cylinder. Fill the cylinder with water, keeping the hole near the bottom sealed until you are ready to begin timing. While two people are preparing the cylinder and water, the third person should prepare to record the times it takes for the water level to reach the various marks on the cylinder.

Recording of Data

Record the height of each mark, the amount of time (from the start of the experiment) it takes for the water level to reach each mark, and the radius of the cylinder.

Analyzing the Data

1. Display your water flow data in a table.

2. Let $H = f(t)$ be the height (in inches) of the water at t seconds after the water begins to flow out of the cylinder. Use a graphing calculator to draw a scattergram of your data.

3. Find an equation of f. The water flow is likely to be a bit erratic at the end, so it's probably best to avoid using a data point that corresponds to a water level of zero.

4. Use a graphing calculator to graph your model and the scattergram in the same viewing window. Graph your model and the scattergram by hand. How well does f fit the data?

5. Find the H-intercept of your model. What does it mean in this situation? Does model breakdown occur before the H-intercept, after the H-intercept, or neither? Explain.

6. Find the t-intercept(s) of your model. What does such a point mean in this situation? Does model breakdown occur before the t-intercept, after the t-intercept, both, or neither? Explain. If there are not any t-intercepts, what does your model imply?

7. Find the vertex of your model. Does model breakdown occur before the vertex, after the vertex, or neither? Explain.

8. Use your model to estimate the height of the water at 20 seconds.

9. Use your model to estimate how many seconds it took for the water level to reach a height of 7 inches.