1. Comprehension and Communication: In your own words, compare and contrast a scientific law (like Torricelli’s), a mathematical theory and a mathematical model.

2. Algorithmic Skill: Describe the shape of the leaky buckets with the following cross-sectional areas and solve Torricelli’s Model (below) analytically for each.

   \[ \frac{dh}{dt} = -\frac{a}{A(t)} \sqrt{2gh} \]

   a) \[ A(t) = t^2 \]
   b) \[ A(t) = \frac{\pi}{2} \csc^2 \frac{t}{2} \]
   c) \[ A(t) = \pi t^4 \]

3. Comprehension and Communication: Describe how you would fit the following data with a quadratic function.

4. Comprehension and Communication: Members of your group provided the following alternate model for the Leaky Bucket Lab, but failed to mechanistically describe the terms in their model. You make the assumption that \( h \) represents height and \( t \) represents time and determine that you can figure it out.

   \[ \frac{dh}{dt} = -\frac{a}{A(t)} \sqrt{2gh} + \frac{\beta h}{t^2} \]

   a) What are the units of the model’s parameters?
   b) Provide a mechanistic interpretation for each term of the model.

5. Application: In the construction of Torricelli’s Model for the Leaky Bucket Lab, we used Bernoulli’s principle that states:

   \[ \frac{v^2}{2} + gh + \frac{p}{\rho} = \text{constant} \]

   where \( v \) is fluid speed, \( g \) is the gravitational acceleration (9.81 m/s\(^2\)), \( h \) is the fluid’s height above a reference point, \( p \) is pressure, and \( \rho \) is density. In the end, this leads to:

   \[ v = \sqrt{2gh} \]

   a) What assumptions were made in Bernoulli’s principle that lead to Torricelli’s Model?
   b) How would the model change if you challenged or adapted those assumptions to better fit the leaky bucket lab setup?