Student handout Consider a thin rod of length L lying on the z-axis. Find an algebraic expression for the mass density of the rod if the charge density at $z = 0$ is λ_0 and at $z = L$ is $7\lambda_0$ and you know that the mass density increases linearly.

1 Instructor's Guide

1.1 Student Conversations/Wrap Up

This activity is surprisingly difficult for some students. This activity is partly an opportunity to introduce language for functional dependence and partly an exercise in modeling physical behavior with a function with parameters that must be determined. Once students get the idea, it's pretty straightforward, but it helps solidify the concept if the exercise recurs a few times as part of future in-class activities and homework.

- Make sure to discuss lots of different language for functional dependence in the wrap-up: linear, quadratic, exponential, falls off like ..., proportional to the square, etc.
- Some students will not realize that they need to start with an equation with one or more unknown parameters in it. In the case of the given prompt: $\lambda(z) = \beta + \alpha z$. Lots of times, you can't write an equation unless you give an algebraic name to the unknowns. We call this strategy "Name the thing you don't know."
- Be particularly aware of the fact that some students incorrectly believe the word "exponentially" means "has an exponent" as in x^2 rather than correctly believe that it means varies like the exponential function $e^{\alpha x}$. Make sure that this topic comes up in the conversation.
- Some possible solution elements:
    1. draw a picture of the rod and label the knowns
    2. draw a graph of the linear charge density
    3. write down the equation for a line and plug in the boundary conditions
    4. calculate the intercept and slope from rise over run