1 Instructor's Guide

1.1 Introduction to Part I

Pass out plastic surfaces. Explain that the height of each surface represents a function $f(x, y)$ of two-variables, x and y. (Some students will have trouble with this idea. It can help to show the painted side of the surface which, as a cross-section, represents a function of one variable.)

1.2 The Prompts and Student Conversations

This activity is a small whiteboard sequence/whole class discussion. Give the students chances to talk with their neighbors, as appropriate.

1. "Find the derivative of the surface." Some students will want to zap and algebraic function and will be flummoxed when they are not given one. Elicit ideas until someone mentions "slope."

2. "Where should you find the slope?" Discuss with the class that slope is a concept that exists at a point. Review, for functions of one-variable the difference between the derivative "function" which gives a formula for the slope of the tangent line at every point and the derivative "at a point" which gives the slope at a particular point. Both of these are reasonable answers to the prompt "Find the derivative."

3. "Find the derivative of the surface at the blue dot." Not there is a NEW feature that does not exist for functions of one variable, there are an infinite number of slopes at the blue dot.

4. "In which direction should you find the slope?" Elicit multiple answers from students: "in the x-direction", "in the y-direction", and "in the steepest direction" are all reasonable answers to this prompt. Introduce/review the concepts of partial derivatives and the gradient.

1.3 Wrap-up to Part I

It is worth talking with students about the reasons we give ambigous prompts:

- In the near future, students will be going to work and/or graduate school. In these settings, no one is going to predigest problems for them. They will have to figure out for themselves what problem needs to be solved. Their boss may well just say, "Fix this" and they will have to figure out what that means.

- As they get further and further into advanced physics settings, they will need to generalize concepts like the derivative to more complex settings. In each such setting, they will have to figure out which parts of the concept are still relevant and which are not and which new things they need to pay attention to.

1.4 Introduction to Part II

1.5 The Prompt and Student Conversations

1. "Use the inclinometer to find the steepest slope of the surface at the blue dot." Most students will struggle a lot to figure out how to use the inclinometer to measure slope. Depending on how much time you have, give them lots of gradual hints ("what is the purpose of the level?") or just show them that the can use the inclinometer to transfer the slope from the surface to a grid.

1.6 Wrap-up to Part II

- This activity emphasizes that the slope is a ratio of rise over run.
- This activity can also be used to talk about experimental uncertainty. "What are the biggest sources of experimental uncertainty in this measurement?" "How can you minimize the uncertainty?"