Student Conversations This activity is a good one for students to practice presenting different parts of their solutions. Valuable conversations that can be add on an individual group basis or as part of the presentations are:

- Does the"height" of the surface actually represent height or some other quantity?
- What are several different ways of observing whether a particular partial derivative is positive, negative, or zero?
- What are the advantages of the measuring tool? What are the limitations?
- How can you tell qualitatively when a partial derivative is large vs. small?
- Some students may conflate the value of the function with its derivative. Others may think that the derivative is large when the slope is changing by a lot. Ask students to distinguish between these concepts.
- If you are using handouts for the contour maps, students may discover that the contour maps can be folded to make an approximation of a surface. This can be tricky for the third contour map (using something made of cloth and using multiple people can help!).

Some students may not draw their origins and label their axes without prompting.

Student handout **On your Marks:** Torches heat a thin $10'' \times 10''$ aluminum plate between $100°F$ and $106°F$. Your surface represents the plate's temperature. Label two points on the surface for each condition below:

1. $\frac{\partial T}{\partial x} < 0$ and $\frac{\partial T}{\partial y} < 0$
2. $\frac{\partial T}{\partial x} > 0$ and $\frac{\partial T}{\partial y} < 0$
3. $\frac{\partial T}{\partial x} < 0$ and $\frac{\partial T}{\partial y} > 0$
4. $\frac{\partial T}{\partial x} = 0$ and $\frac{\partial T}{\partial y} > 0$

Get Set: Pick a point on your surface satisfying the second condition above. Using the measurement tool, find the rates $\frac{\partial T}{\partial x}$ and $\frac{\partial T}{\partial y}$ at your point. (1 vertical inch $= 1°F$.) Include units.

$$\frac{\partial T}{\partial x} = \_\_\_\_\_ \qquad \frac{\partial T}{\partial y} = \_\_\_\_\_$$

Go: For the contour map below, rank the points based on the value of $\frac{\partial T}{\partial x}$ or $\frac{\partial T}{\partial y}$.

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Go: For each contour map below, rank the points based on the value of $\frac{\partial T}{\partial x}$ or $\frac{\partial T}{\partial y}$ at each point.

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$\frac{\partial T}{\partial x}$ Neg. ____ ____ ____ Pos.

$\frac{\partial T}{\partial y}$ Neg. ____ ____ ____ Pos.

$\frac{\partial T}{\partial x}$ Neg. ____ ____ ____ Pos.

$\frac{\partial T}{\partial y}$ Neg. ____ ____ ____ Pos.

$\frac{\partial T}{\partial x}$ Neg. ____ ____ ____ Pos.

$\frac{\partial T}{\partial y}$ Neg. ____ ____ ____ Pos.