Before you is a plastic surface representing the electric potential between two charged plates. A 1 cm height difference corresponds to an electric potential difference of 1 V.

Interpret the Surface

Rank the three points by the value of the electric potential from greatest to least.

> **Instructor's guide** This question is very straightforward and intuitive for students.

Mark three points on the surface that are separated by equal (non-zero!) changes in potential.

> **Instructor's guide** Points should represent equal changes in height. They need not be along a straight line!

Identify (and mark) all the points with the same value of potential as your three points. What patterns do you notice?

> **Instructor's guide** **Answer:** Students should notice that the points with the same potential are straight lines that are equally spaced horizontally.
> **Extension:** What shape of surface would yield lines not equally spaced horizontally? Curved?

Connect Representations

Align your surface with your contour map. How are you making this alignment? Where is the surface a good approximation of the potential? Where is the approximation less good?

> **Instructor's guide** **Answer:** The surface should be in the middle of the capacitor with the lower end of the surface at the negative plate.
>
> **Discussion: How did you align the surface to the contour map?** Ask students to share their alignment strategies:
>
> - **Matching Contours:** Each contour represents a single value of potential. The surface should go in the region where the contours are parallel and equally spaced on the contour map.
> - **Negative Plate:** Students might know or have intuition that the lowest potential will be aligned with the negative plate.
>
> **Extension:** Is the value of the potential negative at the location of the negatively charged plate?

Generate a Graph

Sketch a graph of the potential (V) vs. distance from the negative plate (x).

- Describe the relationship between potential and distance from the negative plate.
- Propose an equation to describe the electric potential as a function of the distance, x, from the negative plate. Where did choose for the location of $V = 0$?

> Instructor's guide **Extension:** Write a symbolic equation for the potential.
> **Extension:** What do you think the potential is not negative near the negative plate?
> **Extension:** Why is it reasonable that the curves of constant potential are straight lines?

Instructor's guide

SUMMARY PAGE

What Students Learn:

- How to interpret a surface plot (plastic surface model) of the potential due to a parallel plate capacitor
- The potential near the center of two charged plates is a plane (constant slope)
- Equipotential curves represent a single value of potential
- Equipotential curves for the center of two charged plates are equally spaced horizontally
- The height of zero potential is arbitrary/chosen for convenience

Time estimate: 15 minutes

Equipment:

- Yellow plastic surface
- Big Whiteboard (1 per group)
- Contour map for a parallel plate capacitor in a plastic sleeve (1 per group)
- Ruler (1 per group)
- Dry-erase pens and erasers (1 each per student)
- Student handout (1 per student)

Introduction

- Try doing this activity BEFORE you talk about the electric field of a parallel plate capacitor and follow up with the "Electric Potential of a Parallel Plate Capacitor" surface activity.
- Students should know that a parallel plate capacitor is two charged planes separated by a distance.
- Students should be familiar with the term "potential" and maybe know the potential due to a point charge (not required but useful for one of the challenge questions).
- NOTE: We chose to have a uniform charge density on the plates rather than make the plates conductors. Therefore, the equipotential curves intersect the plates far from the center.

Whole Class Discussion / Wrap Up:

- Introduce the term "equipotential"
- Have the students propose an equation to describe the electric potential as a function of the distance, x, from the negative plate: $V_{-\to+} = m\,x$ It's linear! Students will learn later that the slope, m, is the magnitude of the electric field.