

Visualizing Multivariable Functions with 3D Plastic Surfaces

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Representations in Physics

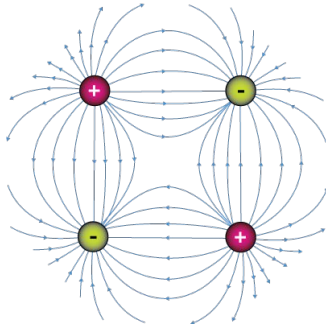


There are many ways to illustrate concepts in physics:

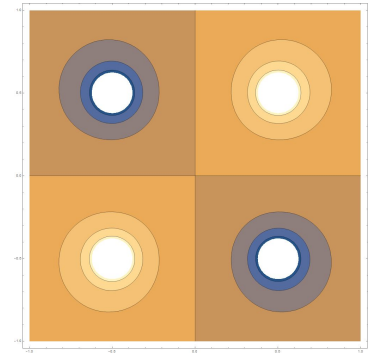
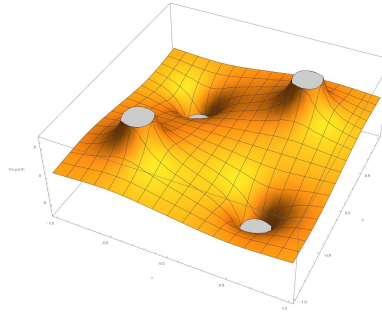
- Equations
- Graphs
- Various types of plots
- Sketches
- Verbal/written descriptions
- Surfaces



“The quadrupole is going to be two positive charges on opposite corners [of a square] and two negative charges on opposite corners.”



<http://xaktly.com/Images/Physics/ElectricField/QuadrupoleFieldLines.png>



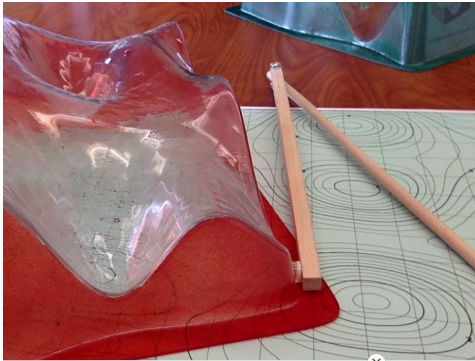
$$V(\vec{r}) = \frac{q}{4\pi\epsilon_0} \left(\frac{1}{|\vec{r} - \vec{r}_1|} - \frac{1}{|\vec{r} - \vec{r}_2|} - \frac{1}{|\vec{r} - \vec{r}_3|} + \frac{1}{|\vec{r} - \vec{r}_4|} \right)$$



What are “surfaces”?

Surfaces are...

...vacuum-formed hard plastic models of functions, used as additional visual and interactive tools.



The Raising Physics to the Surface Project is...

- Activity Development
 - Electromagnetism
 - Mechanics
 - Thermodynamic
- Research
 - How can surfaces help students?
 - How do students use surfaces?
 - What do students think about as they address open-ended questions?
 - What features of surfaces and activities lead to productive discussion?

How can surfaces help physics students?

- They are tangible!
 - Students find it natural to work with surfaces.
- Students work collaboratively while using the surface
- Students make connections between multiple representations.

Student 1: "When we get the surfaces, let's draw some rings on them."

Student 2: "Oh! Cool."

Student 1: "We can look at the projection."



Want to learn more about the research?

PERC Poster Session I

5:00 PM Wednesday, August 1, 2018

Student use and coordination of computerized and tangible visualization tools



Want to learn more about surfaces?

PERC Parallel Sessions Cluster I

8:00 AM Thursday, August 2, 2018

**Encouraging Students to Have Wonderful Ideas About Functions of Several
Variables in Multiple Physics Contexts**

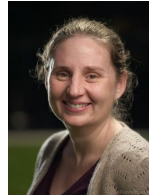
Workshop at the 2019 AAPT Summer meeting in Provo, UT



**Oregon State
University**



DUE: 1612480



Pictured (From top left): Jonathan W. Alfson, Paul J. Emigh, Elizabeth Gire, Aaron Wangberg, Robyn Wangberg.

Also on the Raising Physics team: Abigail Kimbrough, Reese R. Siegel, Michael Trumbull



