Examining student approaches to interpreting and applying multi-variable expressions

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Abstract

Student reasoning difficulties with interpreting and applying multi-variable expressions have been reported previously. For example, students tend to treat the relationship between the wavelength, propagation speed, and frequency as a mathematical identity. That often leads to erroneous conclusions such as "the frequency is changed by changing the speed." We extended this investigation to the contexts of electric field, electric potential, and capacitance. A variety of questions were designed that required students to analyze relationships between various quantities. Significant differences in student reasoning approaches were identified that appeared to depend on whether (1) information presented to students was given in written text and the written text was explicitly translated to the mathematical expression(s) in standard symbolic form or (2) the information was presented in the written form only.

Determining activation energies for hydrogen dynamics in the proton conductor $(NaS)_2Ge(OH)_2.2H_2O$

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Abstract

Protons of a hydrogen molecule of certain hydrated molecular compound are able to move through such compound, but the protons require activation energy (thermal energy in this case). The activation energies for proton in this compound was calculated to be 0.6±0.1 eV (66°-121°) and 0.21±0.02 eV (-5.6°-53°).

Mesoscale nanopatterning using lipid surfactant templating

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Abstract

Contemporary research in the field of nanotechnology/biophysics had shown that nanoparticles or matter on the nanoscale seem to self-assemble or form patterns depending on the environment they are placed in. There are three methods being employed by researchers to manipulate self-assembly and transfer the nanoparticles onto a solid substrate, and this summer I will be using one of those methods. The method is to have nanoparticles interact with a lipid monolayer and then deposit them onto a solid substrate using the Langmuir-Schaefer technique. With the nanoparticles on a solid substrate, I will use an Atomic Force Microscope (AFM) to analyze the patterns.

Using LabVIEW to make a homemade magnetic needle viscometer user-friendly

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Abstract

LabVIEW is a standard programming platform for apparatus design, data collection, and analysis. This program allows one computer to interface with several experimental components simultaneously. I will learn how to use LabVIEW to a proficient level as I implement a single graphical user interface to control the various systems required for operation of Augsburg CollegeâĂŹs Magnetic Needle Viscometer. This device is used to measure the surface viscosity of surfactant films at the air-water interface.

Demixing of Colloid-Polymer Mixtures: Gibbs Ensemble Monte Carlo Simulations with an Implicit Vapor Phase

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Abstract

Using a variation of the Gibbs ensemble Monte Carlo simulation method, we investigate the phase behavior of the Asakura-Oosawa model of a fluid mixture of hard-sphere colloids and nonadsorbing polymers. In this hybrid approach, the colloid-rich (liquid) phase is modeled explicitly via simulation, while the colloid-poor (vapor) phase is modeled implicitly via a thermodynamic free-volume theory. For specific colloid-to-polymer size ratios, we map out the demixing binodal and compare with the phase diagram predicted by free-volume theory, computed from a Maxwell construction of the free energy. While theory and simulation are in good qualitative agreement, quantitative discrepancies can be traced to correlations neglected in the mean-field theory.

Laser Micromachining of Silicon and Polysulfone

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Abstract

Experiments were run to optimize scan speed, power, repetition rate and to minimize debris production for machining of crystalline silicon wafers and polymeric polysulfone. Machining areas and debris production using multiple scans with the 355 nm third harmonic of a Q-switched Nd:YVO_4 laser are presented.

The Poisson-Helmholtz-Boltzmann Model

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Abstract

We present a mean-field model of a one-component electrolyte solution where the mobile ions interact not only via Coulomb interactions but also through a repulsive non-electrostatic Yukawa potential. We employ a local formulation of the mean-field free energy through the use of two auxiliary potentials, an electrostatic and a non-electrostatic potential. Functional minimization of the mean-field free energy leads to two coupled local differential equations, the Poisson-Boltzmann equation and the Helmholtz-Boltzmann equation. Their boundary conditions account for the sources of both the electrostatic and non-electrostatic interactions on the surface of all macro-ions that reside in the solution. We also analyze a specific example, two like-charged planar surfaces with their mobile counter-ions forming the electrolyte solution.

An experimental investigation of lipid monolayer domain size distribution in multi-component systems

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Abstract

The plasma cell membrane is a complex composite fluid which dynamically responds to its environment. My research project will explore the material properties of multi-component model lipid membranes common in the cell membrane. Specifically, we will investigate experimental challenges in the use of domain size distribution as a tool to measure the physical properties of monolayers including the dipole density difference and the line tension between coexisting phases. I will focus on two aspects of monolayer behavior. I will first look at the influence of phase transition kinetics on monolayer domain size distribution; and second, I will conduct a statistical exploration of monolayer homogeneity.

Monitoring the variations of the global electric circuit

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Abstract

Thousands of thunderstorms occur on our planet continuously with countless lightning bolts hitting the ground, delivering a tremendous amount of charge; as a result we live atop an ocean of negative charges that generate an electric field of approximately 100 volts per meter near the earth's surface. When thunderstorms pass overhead, the electric fields can increase to thousands of volts per meter. It is estimated that over 40,000 thunderstorms occur each day around the world; these natural phenomena are what help maintain the electric fields everywhere on the earth's surface. Non-thunderstorm days are known as fair-weather conditions. We are interested in fair-weather conditions for many reasons, the most important being that there recently has been a discovery that links the Global Electric Circuit to phenomena occurring in the local space environment. We will be constructing an electric field mill that will be able to detect and measure the earth's electric field. The device will be inexpensive compared to commercially available field mills. Making a cheaper instrument has its drawbacks, such as a decrease in accuracy. The tradeoff, however, is compensated by an increase in opportunities to collect data; from multiple flights and possibly a wide adoption by a variety of student groups.