Online Proceedings

Poster Session 1

Commons East, Easel 78

11:00 AM to 1:00 PM

Ultrasonic Manipulation of Cell Trajectories in Flow

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Mentor: Tom Matula, Applied Physics Laboratory

Manipulation of cell flow is of great interest in flow cytometry (cell sorting and counting), which has numerous diagnostic and laboratory applications. Current techniques use fluorescent markers or impedance in a Coulter Counter to isolate and quantify cells. This experiment takes a novel approach by utilizing ultrasonic waves to redirect cells in flow. Cells and water have similar acoustic impedances (i.e., ultrasonic forces exerted on cells are similar to those exerted on the surrounding fluid). Ultrasound contrast agents, however, have a much different impedance. Both dense and sparse contrast agent (lipid-shelled microbubbles) flow respond to an acoustic field with a significant, directional forcing. Juvenile T-lymphoblast leukemia cells conjugated with the ultrasound contrast agent via streptavadin-biotin-anti-CD7 antibody linkage were redirected via acoustic radiation force in flow. Video data were analyzed using optical flow techniques for the velocity data herein. Since the conjugation process varies widely in the number of markers that attach to cells, the effect of numerous conjugations on the acoustic forcing is unclear. The data provides proof of concept for a robust cell sorting device at significantly lower cost than traditional flow cytometers.

Poster Session 3

Commons East, Easel 79

2:30 PM to 4:00 PM

A Portable Vacuum Chamber for Gravitational Free-Fall Tests with Sub-Millisecond Resolution

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Phong Nguyen, Junior, Computer Science, Edmonds Community College
Naol Debele, Sophomore, Physics, Economics , Edmonds Community College
Samuel Will, Sophomore, Civil Engineering, Edmonds Community College
Mentor: Tom Fleming, Department of Physics, Edmonds Community College

Direct verifications of the validity of Newton's equations for vacuum free-fall in introductory physics laboratories are notoriously difficult due to the presence of atmospheric interactions between falling objects and their environments. The theoretical result, for example, that the gravitational acceleration of an object is independent of its mass is rather easy for observant students to experimentally reject under normal laboratory conditions. What is not so easy is to experimentally verify the validity of mass-independence in-vacuo. This is hindered by inaccessibility to vacuum environments or access to one small enough to fit in a classroom; such access is limited to organizations like NASA. We present here the construction and testing of a portable 1.5m tall extruded-acrylic vacuum free-fall apparatus designed for repeated-measures experiments of time-of-fall with a 2.5g, 40mm diameter magnetic ball over atmospheric pressure ranges 10-4 Torr $<$ p_chamber $<$ 760 Torr. The apparatus includes 12V electromagnet catch and release system within its all-externally-housed actuating mechanisms, automatic digital data acquisition, and a planar optical laser detection system. By comparing time trials in atmosphere and in vacuum, the difference in free-fall times will be isolated and found to be due to air resistance which is not accounted for in the original Newtonian formula. Parameters for this apparatus can be modified to test other ideas for fluid dynamics, such as coefficients of drag and the effects of fluid density on objects as they move through a fluid while using the already present vacuum environment as a control.

Poster Session 3

Commons East, Easel 77

2:30 PM to 4:00 PM

Improved Cooling Efficiency and Cost-Effectiveness of Bitter-Type Solenoid

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Collin Rhodes, Sophomore, Mechanical Engineering, Edmonds Community College
Duy Nguyen, Sophomore, Chemical Engineering, Physics, Mathematics, Edmonds Community College
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Mentor: Tom Fleming, Department of Physics, Edmonds Community College
Mentor: Billy D. Jones, Edmonds Community College

High-powered electromagnets are used in many different fields of science such as quantum physics and synthesis chemistry. Some projects require a very strong magnetic field to work. This magnet will allow students the freedom to design complex projects that utilize a strong magnetic field However, they are generally quite expensive and only available for use at well-funded research facilities and universities. Thus, we present our research in the design and construction of a cost-effective electromagnet capable of producing a highly-uniform magnetic field that can be used to further undergraduate research at Edmonds Community College. Our principal focus is on the reduction of engineering, fabrication and maintenance costs through a novel radial-flow cooling system which can be easily 3D-printed using high-temperature plastics in conjunction with a solid Bitter-plate solenoid design, requiring far less intricate and less expensive machining processes than conventional staggered-channel Bitter-plate designs. In order to make meaningful comparisons of generated field and thermal profiles with other published designs, our design maintains general shape and structural congruence to a design by Sabulsky, et. al., yet differing significantly in the design of the cooling system.

POSTER SESSION 3

Commons East, Easel 78

2:30 PM to 4:00 PM

Growth of Nickel Sulfate Hexahydrate Crystals in a Magnetic Field

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Shannay Kammann, Sophomore, Mechanical Engineering, Edmonds Community College
Zumrat Makhkamova, Senior, Chemical Engineering , Edmonds Community College
Erica Toikka, Sophomore, Bioengineering, Biology, Nursing, Edmonds Community College
Lauren Valdez, Junior, Computer Science Engineering, Edmonds Community College
Mentor: Tom Fleming, Department of Physics, Edmonds Community College

Nickel sulfate hexahydrate (NiSO4.6H2O) is an important industrial compound most commonly used in the nickel-plating industry. Approximately 40,000 tons are produced and consumed each year by manufacturers requiring corrosion-resistant components ranging from consumer electronics to medical devices and aerospace engineering. Freitas et. al. found that zinc sulfate heptahydrate crystal growth increased by 38% under a magnetic field of 0.3-0.7T compared to crystallization under earth's magnetic field alone, whereas Lundager et. al. have presented evidence that paramagnetic materials such as CuSO4.5H2O do not exhibit such magnetically-induced increases in crystal growth rate. We present here our progress on confirmatory experiments aimed at fitting Nyvlt theory of cumulative crystal weight fraction M(L) and average growth rate G in batch synthesis of diamagnetic ZnSO4.7H2O and paramagnetic NiSO4.6H2O under external, uniform, homogeneous magnetic fields $0.0T<B<1.0T$. Our study will examine the differences in the growth rate of paramagnetic and diamagnetic sulfate crystals under the influence of a manipulated magnetic field. Recrystallization is a method of purification during the synthesis process of many compounds. If recrystallization can be improved to increase percent yield by influencing the magnetic field surrounding the compound, it may be a profitable method for drug manufacturers to consider.

POSTER SESSION 4

Commons East, Easel 71

4:00 PM to 6:00 PM

Development of Photocatalytic Diels Alder Reaction for Incorporation into the Curriculum of Undergraduate Organic Chemistry Laboratories

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UW Honors Program
Mentor: Tomikazu Sasaki, Chemistry

The purpose of this research project is to demonstrate the feasibility of incorporating a new photocatalytic Diels-Alder reaction into the curriculum of undergraduate organic chemistry laboratories at University of Washington. Although the traditional Diels-Alder reaction is thermally allowed and does not require UV light catalysis, it fails to succeed when both the dienophile and diene are electron rich due to electrostatic repulsion between the reagents. Recently, an alternative photocatalytic Diels-Alder reaction was reported in the chemical literature involving a ruthenium bipyrazine catalyst, $Ru(bpz)_3X$, where X denotes the counter anion. This new photocatalytic method is advantageous because it allows the Diel-Alder reaction to work when both the diene and the dienophile are electron rich. Consequently, we believe that the new photocatalytic Diels-Alder reaction would be an attractive addition to our undergraduate laboratory curriculum by increasing the versatility of Diels Alder reagents to accommodate both electron rich substrates. Because the ruthenium catalyst is not commercially available, it must be synthesized from chloropyrazine. Two equivalents of chloropyrazine were coupled together under heated conditions and a $Pd(Ph_3)_4$ catalyst to yield a solution mixture containing bipyrazine, which was purified via silica flash chromatography. Subsequently, bipyrazine was reacted with $RuCl_3xH_2O$ in ethylene glycol at 170C to afford a solution mixture containing $Ru(bpz)_3Cl_2$. This chloride salt was reacted with NaBArF to precipitate the desired catalyst, $Ru(bpz)_3X$, where X represents the anion BArF-. Finally, the catalyst was purified through alumina flash chromatography. We intend to test the efficacy of this new photocatalytic method using the electron rich substrates trans anethole (dienophile) and isoprene (diene) in the upcoming months. We expect that the two photocatalysts we have synthesized will catalyze the cycloaddition reaction between isoprene and trans anethole with endo stereoselectivity.