CSAAPT Spring 2024 Semi-Virtual Meeting

Saturday, March 16, 2024 - Saturday, March 16, 2024

Delaware State University, Bank of America Building

Chesapeake Section of the AAPT
Spring 2024 Semi-Virtual Meeting
March 16, 2024 @
Delaware State University

Book of Abstracts

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Demystifying the use of complex numbers with driven-damped harmonic oscillators

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In 1930, Born and Jordan wrote a quantum mechanics textbook. In that work, they used a curious map to convert the harmonic oscillator equations of motion into two linear (uncoupled) first-order equations. When used in classical mechanics, this mapping clearly shows how one should introduce complex numbers into the motion of a harmonic oscillator and how to solve for the position and momentum observables. In this talk, I will explain how this mapping works and show how to demystify complex numbers usage in damped-driven harmonic oscillators.

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Canceled - DOD STEM RESOURCES

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DOD STEM Resources

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Sticking point: The Role of Quantum Mechanics in Gecko Wall Climbing, and How to Create Synthetic Gecko Tape.

Author: Kausik Das[1]

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This presentation would delve into the fascinating world of gecko locomotion, a topic that captivates both biologists and physicists alike. The remarkable ability of geckos to scale vertical surfaces and even traverse ceilings has long intrigued scientists, leading to groundbreaking insights at the intersection of biology and physics. Central to this ability are the billions of nano-sized hairs, known as setae, found on the feet of geckos. These setae adhere to surfaces not through conventional means like glue, suction, or mechanical grip, but via Van der Waals forces. These forces, though weak individually, collectively enable a gecko's remarkable adhesive capability.

Our presentation will explore the quantum mechanical nature of the Van der Waals force, a phenomenon emerging from the subtle interplay of interatomic forces between the minuscule tips of gecko setae and the molecules of the wall surface. Additionally, we will introduce a simple yet innovative experiment designed for high school and undergraduate laboratories. This experiment

aims to synthesize a 'gecko tape', replicating the gecko's natural adhesive properties using synthetic materials.

BOA 213 / 5

Learning Differences and Physics Teaching

Author: Sean Lally[1]

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You have likely come into contact with many students who have learning differences - some slight, some moderate, and some severe. I currently teach at a school that focuses on the teaching of students with dyslexia and related language-based learning differences and I see all sorts of issues among college-bound high school students. In this talk, I wish to address some of the things you may see exhibited by your students. There is no solution that helps everyone, but there are strategies for teaching physics (and indeed all sciences) that I have found useful. I will chat about executive function, note-taking, lab preparation, classroom practices, and other possible ways to help address learning differences.

Featured Talk 2 / 6

The Physics of NASCAR

Author: Diandra Leslie-Pelecky[None]

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Most people watching a NASCAR race see racecars. Dr. Diandra Leslie-Pelecky sees a science experiment on wheels —and a way to interest more people in physics. She's gotten behind-the-scenes access to race shops and personnel, driven the 24-degree banking of Texas Motor Speedway, and embedded with a race team. She shows fans how a team cannot win a NASCAR race without mastering math, science and engineering, and how their understand of the sport will be enhanced if they learn a little more about the science behind the speed.

In 75 years, NASCAR has evolved from moonshine and dirt tracks to computational fluid dynamics and finite element analysis. Dirt tracks are still part of the picture, but so are sweeping superspeedways and sprawling road courses. NASCAR has changed profoundly in the 16 years she's been reporting on the sport. This will be the third year of racing with the seventh-generation Next Gen racecar, which looks more like a production car and has cutting edge safety features.

NASCAR has even built their first electric racecar.

Dr. Diandra will explain how racing isn't as simple as mv2/r, how you can use cars to increase student interest. She'll also explain how motorsports have the potential to help lead the change to more sustainable vehicles. Whether you're a race fan curious to know why your driver is (or isn't) winning, or a scientist wondering why people get so excited about cars driving in circles, you will enjoy learning about the science of speed.

Dr. Diandra Leslie-Pelecky is the author of "The Physics of NASCAR" and the "Building Speed" blog. She is a contributor to NBC Sports and SiriusXM Speedway. Outlets from the New York Times to Sporting News to Physics World have covered her work and drawn on her expertise.

Featured Talk 1 / 7

The Total Solar Eclipse on April 8, 2024

Author: Matthew Bobrowsky[1]

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This CSAAPT meeting is occurring less than a month before the total solar eclipse that will occur on April 8, 2024. In this presentation, we will describe the fascinating circumstances that will create April's spectacular event. Topics include:

- What is an eclipse?
- Why will the eclipse be so spectacular?
- From where can the eclipse be seen?
- How often do eclipses occur? When is the next one after April 8? (Spoiler alert: If you're in the U.S., you'll have to wait decades [!] to see another total solar eclipse.)
- How to safely view the eclipse. (Eclipse-viewing glasses will be available.)
- Fun facts and common misconceptions about the sun, moon, and eclipses.

There will also be a Q & A session. Come and hear about the eclipse – and then plan to see it!

BOA 101 / 8

Virginia Science Standards of Learning Revision - Seeking Input!

Author: Gregory MacDougall[1]

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The Virginia Science Standards of Learning Revision and Implementation timeline is being revised. This session will provide an update on the revision process. In addition, the VDOE is seeking input from the community on the standards and seeking nominations for individuals who are qualified and available to serve on the Science Standards Revision Committee to review the K-12 Science Standards of Learning during the summer of 2024. Courses of interest include Physical Science, Physics, and Physics II,

BOA 101 / 10

Empowering Students through Open Access Publishing

Author: Stefano Colafranceschi[1]

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This talk explores the role of open access journals in science and physics education, focusing on the importance of publishing for students. Through practical insights and discussions, we will discuss the highlights and benefits of writing for students and the broader scientific community. In addition to discussing the theoretical significance of open access journals in science and physics education, this talk will also draw upon an operational experience in hosting a journal that offers free and open access for students. This perspective sheds light on the practical aspects of engaging students in the process of academic publishing. By providing a platform for students to actively participate in writing and submitting articles and to cultivate a deeper understanding of scholarly communication. Hosting a journal addresses a crucial gap often overlooked in
traditional educational settings, where students may not have sufficient opportunities to explore the machinery of academic publishing.

BOA 213 / 11

THROW THINGS DOWN THE STAIRS AND CALL IT SCIENCE - A DESIGN/BUILD CONCUSSION PROJECT

Author: Mike Florek[1]

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In a given physics classroom, the odds are good that at least one student has had a concussion or has a friend who did. Many students participate in sports or activities with a risk of head injury. This problem-based lesson tackles concussion prevention in football and bridges the disciplines of physics and engineering.
Students are challenged to design their own helmet padding using upcycled packing materials. The test rig is currently a foam head-form with an embedded accelerometer. Students must complete a set of blueprints, construct the designs, and then test for efficiency.
I will walk you through the phases of the project, providing insight from missteps and successes, and share adjustments I will try in the next iteration. We will step through a dry run of the data collection with old designs.

BOA 217 / 12

Using hand-held visual accelerometers and the CER Framework in student-centered classrooms to talk through FCI misconceptions.

Author: Judson Wagner[1]

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In establishing student-centered learning environments, educators look for ways to prompt student-directed exploration, rich and authentic discourse, and collaborative peer instruction, while eliciting evidence of student learning. The Claim-Evidence-Reasoning (CER) writing framework can help classrooms normalize effective student-centered science activities. This presentation offers educators a strategy in a student-centered environment that uses Force Concept Inventory (FCI) misconceptions to quickly guide students to make a claim, puts visual accelerometers into students'hands to help them to quickly explore and present evidence, and consequently, give students more time to craft their scientific reasoning that ties the claim and evidence together and contributes to their enduring conceptual understanding.

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Experimental Projects for a Capstone Engineering Physics Course at Delaware State University

Author: Aristides Marcano[1]

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The presentation discusses capstone experimental projects designed for senior students majoring in Engineering Physics at Delaware State University. In this capstone experience, students complete a total of ten short experimental projects in two semesters from a repository of twenty laboratories, which include experiments in electrical circuitry, spectroscopy, modern physics, thermodynamics, acoustics, optics, and renewable energy technology. Students are expected to conceive and design the experimental protocol to test the hypothesis or verify a known theory. Students prepare a technical report upon completion of each experiment. They also make an oral or a poster presentation for one experiment of their choice as a culminating assessment. Students are guided to prepare reports and presentations following the structure/format similar to a regular scientific communication. To enhance the creativity of the experience, students also perform additional mini-projects based on Arduino microcontroller kits.

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Navigating Challenges and Alternatives in Physics Education: An Engineer's perspective

Author: Andres Akamine[1]

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Engineering challenges of the 21st century will continue to need science majors who can think creatively. If young people are to become adepts in science, they must be taught how to interpret for themselves. This presentation shares the challenges and alternatives to be proficient at teaching physics education from an engineer's perspective. The main challenges identified include student self-regulation, mathematical skills, and the heterogeneity of student groups. To address these challenges, alternative approaches such as implementing strong curriculums, emphasizing experiential learning, and leveraging technology are discussed. By fostering self-regulation, promoting positive attitudes towards math, and accommodating diverse learning needs, educators can create a supportive learning environment conducive to student success in physics education. Through innovative strategies and a commitment to excellence, engineers and educators play a crucial role in shaping the future of scientific inquiry and technological innovation.

BOA 213 / 15

Exploring ChatGPT for Creating Curricular and Instructional Material

Author: Muge Karagoz[None]

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Every STEM teacher has likely already considered using Generative AI tools in their courses, if not already applied. In this talk, I will examine two separate uses of ChatGPT for physics: One to create course material, and another to perform case studies for promoting critical thinking skills. I will share my experiences on testing ChatGPT for re-generating some figures I previously created using TikZ (a LaTeX package for graphics) for a UMD upper division physics course on waves and oscillations. I will then finish with illustrating how ChatGPT's responses can be used as part of in-class peer-led and teacher-led discussions.

BOA 217 / 16

Building Student Interest in Quantum Careers: Quantum Pathways Programs

Authors: Jessica Rosenberg[1]; Nancy Holincheck[1]; Benjamin Dreyfus[1]

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We will discuss two programs that we have been running to introduce students to quantum concepts and the pathways into quantum careers. The Pathways to Quantum Summer Immersion Program introduces high school students to key quantum concepts and the jobs in quantum. The program is an immersive experience that includes a virtual program to build an understanding of key concepts and an in-person program that focuses on learning about quantum careers through site visits. The Quantum Pathways program was a one-day workshop pilot aimed at community college and early college students to introduce them to quantum key concepts and to help them understand how they could pursue a career in quantum. We will discuss the key elements of these programs and what we have learned about students'thinking about quantum concepts and careers through these experiences.

BOA 101 / 17

Learn about the Heliophysics Big Year events such as the eclipse through NASA's Community Coordinated Modeling Center's (CCMC) tools

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The Heliophysics Science Division at NASA Goddard Space Flight Center (GSFC) is calling October 2023 through December 2024 the Heliophysics Big Year (HBY). Learn about heliophysics, and how you can use the Community Coordinated Modeling Center's (CCMC's) tools to engage with the events from the annular eclipse from last October, this upcoming total solar eclipse on April 8th, and Parker Solar Probe's closest approach to the sun on December 24th. The CCMC has hands-on space weather modeling tools for formal and informal educators. The CCMC supports educational activities, such as heliophysics and space weather summer schools, contests, research visits and exchanges. We create and maintain a wide variety of tools for space weather simulations, analysis, forecasting, and visualization. This includes tools such as the iNtegrated Space Weather Analysis System (iSWA), Database Of Notifications, Knowledge, Information (DONKI), and OpenSpace 3D visualization project.

BOA 213 / 18

Highlights from Two-Year College Programs

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The Organization for Physics at Two-Year Colleges (OPTYCs) is an NSF-funded project to bring two-year college physics and astronomy faculty together through professional development and networking opportunities. In this presentation, I highlight two of our cohort-based programs: the New Faculty Development Series, and the DEI Capacity-Building Program. OPTYCs is supported by NSF grant #2212807, and activities are open to everyone. For more information, visit: https://optycs.aapt.org.

BOA 217 / 19

Mechanical Oscillations With and Without Damping - An Analog Computer Physics-Themed Simulation

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A breadboard analog computer was constructed to approximate a solution to the second-order linear differential equations for a sliding block attached to a massless spring, which is attached to a rigid vertical frame. Two cases are considered: (1) with damping and (2) without damping. In both cases, the sliding friction is assumed to be 0. Units were omitted in each equation for clarity. The solutions to both cases are displayed on an oscilloscope upon initialization. An analytical solution is provided for each case as comparison. This demonstration provides a model of instruction which allows students to visualize classical physics and differential equations through hands-on analog circuit design.

BOA 101 / 20

Social Dynamics around a Black Woman's Equipment Handling in a Physics Lab

Author: Mark Akubo[1]

Co-authors: Emily Stump, [2]; Natasha Holmes [2]

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In undergraduate physics laboratory courses, there is new emphasis on engaging students in authentic science learning experiences centering on knowledge-building. Limited research, however, has sufficiently explored the ranges of positioning dynamics around equipment handling roles, particularly in gender and racially diverse groups. This is especially true for the experiences of women of color. We seek to identify and describe the dynamics of students'positioning around equipment handling in multiple diverse groups that included a Black Woman who indicated preference towards handling lab equipment. We draw on literature on positioning theory, discourse analysis, roles, small groups, and physics labs to analyze episodes of video on the groups. We characterize each group's dynamics, identified participants'roles around equipment handling, and wrote memos on the positioning dynamics. We find that students enacted three positioning dynamics in the groups: explicit assignment, implicit assignment, and explicit negotiation. Also, different positioning dynamics and distinct types of interactions across groups shaped the Black woman's participation around the equipment handling role. The complexities in interactions and positioning dynamics across groups increase the weight of evidence that suggests explicit role assignment in small groups does not guarantee group work equity.

BOA 101 / 21

Examining the Role of Family in Women's Engagement and Success in Physics

Author: Laura Akesson[1]

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Although some progress has been made over the last 50 years, physics still has one of the largest gender gaps of the sciences. The gap has been attributed to a variety of causes, including aspects of culture, early exposure to STEM, and gender-based psychologies, but few studies approach this issue centering the perspectives and experiences of women in physics. We focus on the role of family to understand the engagement and success of undergraduate women in physics. In this presentation, we will discuss our qualitative analysis of 120 surveys and 31 interviews of undergraduate physics students (92% identifying as female). We relate our findings to recent established STEM- and physics identity frameworks (including Carlone & Johnson and Hazari), and present new aspects emerging from our data.

BOA 101 / 22

Enhancing STEM Graduate Student Teaching: The cultivation of teaching skills and identity among graduate students.

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We examine the evolution of the teaching identity of graduate teaching assistants (GTAs) during their first year as they engage in teaching professional development and gain experience in the classroom. This study is part of a larger project that aims to increase active and collaborative learning in Math, Physics, and Computer Science at George Mason University. To prepare and support GTAs, the project has established pre-semester and academic-year professional development initiatives. The pre-semester workshop spans two days and aims to ready new GTAs for their classroom responsibilities. It covers practical teaching skills, emphasizing active learning, making a positive first day impression, available resources, and fostering a welcoming and inclusive classroom atmosphere. Academic-year professional development varies among departments but typically involves weekly meetings of GTAs, serving as a platform for discussing teaching methods and strategies. Following the two-day workshop in August 2023, we conducted seven focus groups, each comprising 3-4 GTAs. Currently, we are conducting one-on-one interviews to gain a deeper understanding of how GTA teaching identities evolve over time and to examine potential differences in experiences for international GTAs. The data collected from these focus groups and interviews provide preliminary insights into the development of teaching identity for new GTAs.

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Let it go!

Authors: Henry Hilgendorf[1]; Tatsu Takeuchi[1]

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In this demo, we roll cylindrical objects down a ramp to see which one reaches the bottom first. The speed is determined by how the initial gravitational potential energy is shared between the translational and rotational kinetic energies of the rolling object. The highlight of the demo is the race between Frozen and Thawed cans of orange juice.

BOA 217 / 24

Tautochrone and Brachistochrone

Author: Tatsu Takeuchi[1]

[1] *Virginia Tech*

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We will show how to construct tracks you can rolls marbles along simply and cheaply. These tracks can be used to demonstrate the tautochrone and brachistochrone.

BOA 101 / 25

Physics of an Accelerating Unicycle

Author: Carl Mungan[1]

[1] *U.S. Naval Academy*

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The free-body diagram of a unicycle pedaled across level ground is analyzed, showing that riders must tilt their bodies into the direction of the acceleration. A comparison is made with an unpowered round object rolling without slipping up or down an inclined plane. A Newtonian analysis predicts an acceleration of the unicycle as a function of the tilt angle that is in good agreement with measurements of an actual unicycle using the accelerometer on a smartphone. This work has been performed in collaboration with Heiko Kabutz, Ph.D. student of mechanical engineering at the University of Colorado in Boulder.

BOA 101 / 27

Finding The Right Amount of Flip

Author: Jason Sterlace[1]

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The idea of the Flipped Classroom has been around for many years, but in order for it to be valuable the purpose of the flip must be clearly understood, and the method must be used judiciously. Over-flipping leads instructors and students alike to believe that the entire process is poor pedagogy.

In this talk, I describe the general Flipped Classroom and analyze the parts of the introductory physics course that could be flipped to the best benefit of the student and the instructor. Attention will be given to engendering student participation in the process, and identifying aspects of the course that do not work well with this pedagogy.

BOA 213 / 28

Specification grading in introductory physics for astronomy and physics majors

Author: Veronique Petit[1]

[1] *University of Delaware*

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Retention of physics and astronomy majors at the University of Delaware has been a long-standing issue. We will describe the course structure that we have adopted for a section of introductory physics dedicated to students in our physics BS, BA, and astronomy BA programs. In addition to implementing specification-based grading, we have also explored the addition of computational physics through the use of the textbook "Matter and Interactions". We will report on our experience in this course, on the feedback from our students, and on some of the problems we are still facing (with the hope of gathering suggestions for improvement by the other participants!)

BOA 217 / 29

Inertia

Author: William A. Tobias[1]

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The resistance to change in physical systems shall be demonstrated via some attention grabbing challenges which will include "Bottle and Pencil" where one tries to drop a writing utensil into the neck of a glass bottle while a knitting loop blocks its path and "Breaking Broomstick" which dares to ask if one can break a length of wood in half while its ends are resting horizontally upon a pair of wine glasses.

BOA 217 / 30

Quantum Science for K-12: A Review of Curriculum and Instruction

Author: Meveryn Chua[1]

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There is a need to deepen and widen the learning of quantum science in schools. Quantum science is mostly taught in colleges while K-12 students learn quantum science mostly through extracurricular programs. This paper reviews the curriculum and instruction of quantum science courses in K-12 schools. The major findings are discussed in relation to the teaching of quantum science in Virginia.

BOA 213 / 31

The Axis of Symmetry of the Lorentz Transform

Author: Lewis McIntyre[None]

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The velocity triangle is a graphical construct for solving various problems of the Lorentz Transform in special relativity. This construct assumes that all matter travels at the speed of light in four-dimensional space, defining the direction of that travel as the local time axis. Relative velocity results from a difference of direction, through the Brehme velocity angle beta, the sine of which equals v/c. The Lorentz Transform, expressed trigonometrically using beta, shows that relative motion is the projection of the passage of time in one reference frame onto the temporal and spatial axes as time varying components with velocity v/c. The trigonometric expression and the velocity triangle reveal that the Lorentz Transform has an axis of symmetry for which ct1=ct2 and x1=-x2, which allows quick graphical solution of any combination ct, x into another reference frame.

The velocity triangle is of my own development, though it is similar to the Brehme diagram developed by Robert Brehme of Wake Forest University in 1964, with whom I had several conversations before his passage. The main difference between the Brehme diagram and the velocity triangle is that the orthogonality of the spatial and temporal axes are maintained, along

with equal units of measure in both reference frames, allowing the measurement of an event by three or more reference frames to be depicted on the same chart. No other Lorentzian time-space diagram supports this, as all distort the units of measure and orthogonality of one or both reference frames.
The axis of symmetry is wholly original to my work.

BOA 213 / 32

Can students spot AI's physics errors? An experience with GPT in the classroom

Author: Alejandro Satz[None]

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This talk documents an attempt to use AI text-generation tools for pedagogical purposes in an introductory physics course. In a PHYS 101 (algebra-based introductory mechanics) course at Harford Community College in Fall 2023, the instructor assigned review activities in which students had to analyze AI-generated answers to physics problems and questions, spotting mistakes and distinguishing correct answers from incorrect ones. The talk with give examples of such activities, discuss the (mixed) student response and evaluate the pros and cons of this kind of assignment.

Welcome / 37

Welcome and Introduction

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BOA 217 / 49

Empowering STEM Education: The Delaware Space Grant Consortium's Innovative Approach

Author: Dwight Higgin[None]

The Delaware Space Grant Consortium (DESGC) is a multi-institution partnership committed to advancing STEM (Science, Technology, Engineering, and Mathematics) education. At the college level, DESGC provides fellowships and scholarships to students attending 2-year and 4-year colleges throughout the State and aids in professional development of STEM-related educators. This talk delves into the multifaceted approach taken by the Consortium to enrich STEM education through education and research opportunities. From supporting student-led research projects to fostering collaborations with academic institutions and industry partners, the Delaware Space Grant is at the forefront of promoting hands-on scientific inquiry and exploration. By integrating research experiences into educational frameworks, students gain invaluable skills and insights while contributing to cutting-edge discoveries.

BOA 213 / 50

Where is physics going in public schools in Delaware?

Author: Tonyea Mead[None]

Participants will have an opportunity to hear how NGSS physical standards fit into the K-12 educational system and how it is taught. What are the challenges in Delaware and across our nation in teaching physics. Participants will have a discussion on how we might possibly solve some of these challenges.