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John Essick, Jesse Kinder, Claire A. Marrache-Kikuchi, Raina Olsen, Beth Parks, B. Cameron Reed, Donald Salisbury, Todd Springer, and Keith Zengel, Editors

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These brief summaries are designed to help readers easily see which articles will be most valuable to them. The online version contains links to the articles.

Orbital mechanics with the Global Positioning System

William H. Baird and Kelly R. Patton
92(6), p. 407. https://doi.org/10.1119/5.0146547
Global Navigation Satellite Systems, such as GPS, have locations that must be known very precisely and that are publicly available. For that reason, they provide an ideal data set for studying orbits, both at an introductory level and for more advanced projects such as observing the effects of Earth's equatorial bulge, the Moon's gravitational attraction, or solar radiation pressure. The authors provide Python scripts that will process the satellite data into formats that can be used by students.

Lagrange points and regionally conserved quantities

Eric M. Edlund
92(6), p. 414. https://doi.org/10.1119/5.0160904
The James Webb telescope is today providing an astounding view of the early universe. It is located at a fixed equilibrium position relative to the earth and the sun - a so-called Lagrange point. This article offers an innovative derivation of these Lagrange points, employing a notion of local conservation that can be exploited in upper-level undergraduate mechanics courses.

Dynamics of a bouncing capsule: An impulse model vs. a Hertzian model

Xinrui Li, Guangyuan Chen, Ren Jie Tee, Jie Xu Liu, and Christopher Ong
92(6), p. 424. https://doi.org/10.1119/5.0169258
We all know that a ball dropped from rest will not rebound all the way to its original height, but that does not mean that rebounds to greater heights are not possible. A capsule-shaped object dropped from rest with an initial angular velocity might convert some rotational energy into potential energy and end up higher than it started. The authors present and compare two models that make this simple but surprising experiment accessible to a wide range of students.

On Bell's dynamical route to special relativity

Frederick W. Strauch
92(6) p. 434. https://doi.org/10.1119/5.0159408
In this paper, the author explores a suggestion by John Bell for teaching special relativity: To introduce length contraction and time dilation as dynamical phenomena arising from the laws of motion, without reference to the Lorentz transformations. The paper provides historical and philosophical insight into the development of special relativity alongside an analysis of electron orbits in a classical model of an atom. Using only the Lorentz force law, the author illustrates the deformation of orbits of moving and accelerating atoms with approximate, exact, and numerical calculations that reveal time dilation and length contraction. Instructors may find these derivations useful in teaching courses on modern physics, relativity, classical mechanics, electrodynamics, or numerical methods.

Determining the difference between local acceleration and local gravity: Applications of the equivalence principle to relativistic trajectories

Steven A. Balbus
92(6) p. 444. https://doi.org/10.1119/5.0162082
Linearized differential equations appear in this article in the context of light and particle deflection in Schwarzschild spacetime, the simplest metric solution of Einstein's equations. The procedures can be easily employed in upper-level undergraduate courses, and the results illustrate the frequent failure of the Einstein equivalence principle in predicting deflection due to spatial curvature. The full geodesic equations are themselves readily accessible, but they need not necessarily be derived or addressed in order for students to gain an appreciation of the limited validity of equating particle motion in an accelerating Lorentz frame of reference to motion under the influence of Newtonian gravity.

On the state principle of classical thermodynamics

J. G. Smith and B. E. Schmidt
92(6) p. 450. https://doi.org/10.1119/5.0179939
The state principle of classical thermodynamics asserts that the state of a simple compressible system can be uniquely determined by specifying two properties, such as temperature and pressure. However, there are situations where such a specification does not guarantee a unique state; for example, specifying the pressure and temperature of liquid water around its freezing point gives two possible volume states. In this paper, the authors explore how to guarantee a unique state by choosing two properties from the trio of a thermodynamic potential and its two natural variables. A handy table of results lists 12 pairs of intensive variables that are guaranteed to specify a unique state for a single-phase, single-component substance. It is appropriate for intermediate-level thermodynamics students.

A new unit of measurement for introductory physics lab

Christopher Aubin, Jan C. Bierowiec, and Jackson Saunders
92(6) p. 455. https://doi.org/10.1119/5.0159531

Experimental research in physics often involves repeated measurements of an unknown quantity by different groups. Ultimately (after careful analysis and comparison of results), a scientific consensus can be reached. This process often differs from a traditional undergraduate laboratory experience, where students might already know the result and simply aim to confirm it. In this article, the authors describe one way to make the laboratory experience more scientifically authentic: By developing special measuring devices that employ a newly created, nonstandard system of units. This article will be of interest to readers who would like to develop curricula which foster scientific reasoning and research skills.

Linewidth measurement of external cavity laser

Tom A. Kuusela
92(6), p. 459. https://doi.org/10.1119/5.0207084
This paper presents a low-cost interferometric technique for measuring the linewidth of a laser. The author first provides context for the interferometric technique by giving a comprehensive, clear, and detailed description of other techniques that can be used to measure a laser's linewidth, including the benefits and drawbacks of each. The principle behind the interferometric method is then presented and the required experimental setup is explained. Data obtained by applying the interferometric technique to an external cavity laser are presented and the analysis of these data, along with the resulting linewidth value, is given. This work provides a well-suited experiment for an advanced instructional physics laboratory or optics/laser course. It will also hold appeal as a cost-effective tool for laser linewidth measurement in laboratory research.

Quantum versus classical quenches and the broadening of wave packets

K. Schönhammer
92(6), p. 466. https://doi.org/10.1119/5.0174441
Quantum quenches occur when the Hamiltonian of a system is suddenly changed, so that the system is driven out of equilibrium. This paper, appropriate for graduate-level quantum mechanics classes, examines the similarities and differences of quantum quenches compared to their classical counterparts for three one-dimensional examples: The harmonic oscillator, the linear potential, and the zero potential for which the broadening of a non-Gaussian wave packet is addressed.

Mutual inductance between an infinite solenoid and a surrounding loop – A paradox resolved

Ian C. Malcolm
92(6) p. 473. https://doi.org/10.1119/5.0172133
When students obtain the right answer using an unjustified method, instructors are faced with a grading quandary. Finding himself in that situation, this author asked "Why?" The resulting paper, which will be enjoyed by instructors of electromagnetism, shares the explanation, involving the mutual inductance of a solenoid and a loop.

On the "contact" hyperfine interaction

Wayne M. Saslow
92(6) p. 476. https://doi.org/10.1119/5.0174056
In this short note, author Wayne Saslow examines the history of the contact hyperfine interaction, and he revisits and elucidates a calculation by Hendrik Casimir from 1936. The note illustrates how the hyperfine interaction emerges within the framework of classical electrodynamics, and it reveals how the interaction of two spatially extended current distributions can give rise to what appears to be a singular "contact" interaction. The calculation provides a link between classical electrodynamics and quantum mechanics and should be accessible to students in a junior-level electrodynamics course.

Review of *The Visual Elements—Photography: A Handbook for Communicating Science and Engineering* by Felice C. Frankel

Ram Seshadri, Reviewer
92(6), p. 479. https://doi.org/10.1119/5.0216761