American Journal of Physics

EDITORIAL | DECEMBER 01 2020

In this issue: December 2020 FREE

Beth Parks

Am. J. Phys. 88, 1033–1034 (2020)
https://doi.org/10.1119/10.0002403

In this issue: December 2020

Beth Parks, *Editor*

(Received 10 October 2020; accepted 10 October 2020)
https://doi.org/10.1119/10.0002403

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.

Regular readers will note the temporary increase in the length of the journal as we try to decrease the backlog of manuscripts.

AJP adopts double-anonymous reviewing

Beth Parks, Editor
88 (12) p. 1035
https://doi.org/10.1119/10.0002460

The Poynting effect

Giuseppe Zurlo, James Blackwell, Niall Colgan, Michel Destrade
88 (12) pp. 1036–1040
https://doi.org/10.1119/10.0001997

If a solid rubber cylinder is twisted, will it grow longer or shorter? This question was answered experimentally by John Poynting in 1909, but the analytical explanation is non-trivial. This manuscript provides a simple explanation using energy considerations, appropriate for an intermediate-level mechanics course.

A simple demonstration of shear-flow instability

Tom Howard and Ana Barbosa Aguiar
88 (12) pp. 1041–1048
https://doi.org/10.1119/10.0002438

Fluid instabilities are usually difficult to illustrate in labs and demonstrations. A simple classroom demonstration of a "barotropic instability," supported by numerical analysis, is of particular interest to undergraduates in geophysics.

Comparative structural stiffness: Exploiting 3D-printing

Lawrence N. Virgin
88 (12) pp. 1049–1058
https://doi.org/10.1119/10.0001756

3D printing is used to make a variety of cantilevers that allow undergraduates to probe the effect of cantilever geometry on stiffness and vibration frequency. This article is particularly useful for students of statics and strength of materials.

Tidal locking and the gravitational fold catastrophe

Andrea Ferroglia and Miguel C. N. Fiolhais
88 (12) pp. 1059–1067
https://doi.org/10.1119/10.0001772

The gravitational phenomenon of tidal locking is explored using the effective potential for two orbiting, spinning objects. The limiting case in which one of the objects is point-like is studied in detail, with Mars's moon Phobos given as an example. Appropriate for undergraduate or graduate classical mechanics courses.

Fourier analysis of the non-linear pendulum

Peter F. Hinrichsen
88 (12) pp. 1068–1074
https://doi.org/10.1119/10.0001788

For a pendulum undergoing large amplitude oscillations both with and without damping, the motion is represented using a many-term Fourier approximation and is compared with experimental results.

A magnetic velocity Verlet method

A. Chambliss and J. Franklin
88 (12) pp. 1075–1082
https://doi.org/10.1119/10.0001876

This manuscript introduces an improved method of computing the trajectories of charged particles in magnetic fields, including magnetic confinement geometries. The method could be easily incorporated into an undergraduate E&M or computational physics course.

Improving student understanding of electrodynamics: The case for differential forms

S. Fumeron, B. Berche, and F. Moraes
88 (12) pp. 1083–1093
https://doi.org/10.1119/10.0001754

Differential forms are introduced to help illuminate certain features of electromagnetism. Two examples related to the electromagnetic properties of the classical and quantum vacuum illustrate the power of using differential forms. Appropriate for graduate-level students.

A hands-on quantum cryptography workshop for pre-university students

Adrian Nugraha Utama, Jianwei Lee, and Mathias Alexander Seidler
88 (12) pp. 1094–1102
https://doi.org/10.1119/10.0001895

A quantum cryptography workshop teaches high-school students about the conventional BB84 quantum key distribution protocol. In this hands-on session, a simplification is made to the original protocol, creating a security loophole that student hackers can exploit. Appropriate for motivated high-school or undergraduate students.

On the virial theorem for a particle in a box: Accounting for Cauchy's boundary condition

R. Cabrera-Trujillo and O. Vendrell
88 (12) pp. 1103–1108
https://doi.org/10.1119/10.0001802

The virial theorem is demonstrated for a particle in a box, using Cauchy's boundary conditions to account for the

average force exerted by the walls on the particle. Appropriate for an undergraduate quantum mechanics class.

Noninteracting electrons in a prototypical one-dimensional sinusoidal potential

David C. Johnston
88 (12) pp. 1109–1122
https://doi.org/10.1119/10.0001863
The band structure of non-interacting electrons in a one-dimensional metallic structure with a periodic sinusoidal potential is studied, using numerically-exact solutions to the Mathieu-Schrodinger equation. Appropriate for an advanced class in solid state theory.

Spatial filtering of structured light

Jonathan Pinnell, Asher Klug, and Andrew Forbes
88 (12) pp. 1123–1131
https://doi.org/10.1119/10.0001881
Spatial filtering is a commonly-used technique to improve the quality of laser light by optically filtering the noise. Here a theoretical and experimental framework is developed to spatially filter "structured" light–i.e., light having an arbitrary beam profile. Appropriate for both undergraduate and graduate optics classes.

Full-field optical coherence tomography – An educational setup for an undergraduate lab

Kai Pieper, Gaël Latour, Jens Küchenmeister, Antje Bergmann, Roman Dengler, and Carsten Rockstuhl
88 (12) pp. 1132–1139
https://doi.org/10.1119/10.0001755
Optical coherence tomography (OCT) is a measurement technique for non-invasive imaging of interfaces in bulk samples. A simple OCT setup, built from a Michelson interferometer and a microscope, is described, which can be used for undergraduate lab projects.

Complete and commented translation of Guillaume's 1896 paper on the temperature of space

A. K. T. Assis and M. C. D. Neves
88 (12) pp. 1140–1144
https://doi.org/10.1119/10.0001775
The paper translated is of interest as a reminder of the state of astronomy and physics at the end of the 19th century. It also provides an example, very appropriate for undergraduates, of the application of physics to astronomical questions.

Gyroscopes simply explained with Coriolis pseudotorques

Richard H. Price
88 (12) pp. 1145–1146
https://doi.org/10.1119/10.0002141
A new way to explain why a gyroscope doesn't fall: In a frame that rotates with the gyroscope, the gravitational torque is exactly balanced by the torque from the Coriolis pseudoforce. Appropriate for introductory mechanics students who understand acceleration in rotating frames.

An undergraduate-oriented comment about inverting spectral data to determine the interatomic potential

Jacob Katriel
88 (12) pp. 1147–1150
https://doi.org/10.1119/10.0001753
An elementary example is given that shows the insufficiency of the energy spectrum to determine the interatomic potential, even when the bound states form a complete set. Appropriate for advanced undergraduates.

Slow-dissipation limit of the harmonic oscillator with general power-law damping

Jarrett L. Lancaster
88 (12) pp. 1151–1155
https://doi.org/10.1119/10.0001794
A resistance to motion in a harmonic oscillator is typically presented as either linear or quadratic in the velocity. Here a generalization is given for any power of the velocity. The presentation is best suited for advanced undergraduates.

Coherent control of NV^- centers in diamond in a quantum teaching lab

Vikas K. Sewani, Hyma H. Vallabhapurapu, Yang Yang, Hannes R. Firgau, Chris Adambukulam, Brett C. Johnson, Jarryd J. Pla, and Arne Laucht
88 (12) pp. 1156–1169
https://doi.org/10.1119/10.0001905
The negative nitrogen vacancy center in diamond provides an opportunity for undergraduates to do hands-on experiments controlling electronic spin states in a low-cost laboratory setup.

3D-printing an external cavity-diode laser housing

E. Brekke, T. Bennett, H. Rook, and E.L. Hazlett
88 (12) pp. 1170–1174
https://doi.org/10.1119/10.0002135
3D printing enables the construction of an external-cavity laser diode at an order-of-magnitude cost reduction compared to a commercial system. This design enables new spectroscopy experiments in the undergraduate curriculum and will also be helpful in some research labs.

Review of *Manhattan Project: The Story of the Century* by Bruce Cameron Reed

Harry Bernas
88 (12) p.1075
https://doi.org/10.1119/10.0002457