LETTERS TO THE EDITOR

Letters are selected for their expected interest for our readers. Some letters are sent to reviewers for advice; some are accepted or declined by the editor without review. Letters must be brief and may be edited, subject to the author's approval of significant changes. Although some comments on published articles and notes may be appropriate as letters, most such comments are reviewed according to a special procedure and appear, if accepted, in the Notes and Discussions section. (See the "Statement of Editorial Policy" in the January issue.) Running controversies among letter writers will not be published.

UNCERTAINTY OF THE SLOPE FOR HIGHLY CORRELATED DATA

A recent Note by Jack Higbie[1] showed that one can easily obtain the slope uncertainty, for data fitted to a straight line $y = ax + b$, from the correlation coefficient R^2 provided by most curve-fitting software packages and advanced hand calculators;

$$\text{relative error of slope} = \sigma_a/a = \sqrt{\frac{(1/R^2) - 1}{N-2}}.$$

There is a difficulty, however, when R^2 is so close to unity that the limited number of decimal places displayed leaves no precision in the difference $(1/R^2) - 1$. A simple trick in this situation is the following:

(1) Find a *first approximation* to the slope, which we'll call a_0.

(2) Compute a *revised* set of data points,

$$(y_{\text{new}})_i = (y_{\text{original}})_i - a_0 x_i.$$

(3) Plot $(y_{\text{new}})_i$ against x_i, and curve fit the line $y_{\text{new}} = a_1 x + b$. The *new* correlation coefficient $(R^2)_1$ should now be substantially less than one.

(4) Then the (original) slope and its error are given by:

$$a = a_0 + a_1$$

$$\sigma_a = a_1 \sqrt{\frac{(1/R^2)_1 - 1}{N-2}}.$$

This trick follows the strategy suggested by Lichten.[2] One can only hope that the next generation of curve-fitting programs will provide the uncertainty estimates directly without extra patchwork by the user.

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[1]Jack Higbie, "Uncertainty in the linear regression slope," Am. J. Phys. **59**, 184–185 (1991).
[2]William Lichten, *Data and Error Analysis in the Introductory Physics Laboratory* (Allyn & Bacon, Boston, 1988), p. 45.

WHAT ARE WE TRYING TO DO IN OUR INTRODUCTORY COURSE?

Considerable discussion has been generated lately concerning the content of the two-semester, calculus-based physics course.[1–4] The consensus seems to be that too many students leave the standard two-semester physics course without an appreciation of the broad spectrum of problems currently being addressed by working physicists. This perception carries over into the general populace where, when pressed, the average citizen can only say that physicists study mechanical systems and build bombs. This is certainly contradicted by physics in the news but the perception remains.

While it is true that many students are attracted to the concrete explanations of the world that classical mechanics provides, students are also genuinely interested in the modern problems facing physicists. It is small wonder that students come away from an introductory course somewhat confused and disappointed when they hear about recent developments in physics that are never even mentioned in their college physics course.

One approach to the question of what to do in the introductory course is to consider what tools a working physicist needs. The introductory course should introduce students to the standard mathematical and physical concepts in use in the main stream of current physics research. The primary concepts available in the standard "toolbox" of every working physicist should be introduced in some form at the earliest opportunity.[5]

For example, 34% of the postdoctoral and full-time employed physicists surveyed by the American Institute of Physics in 1987–88 were classified in the field of condensed matter. Since a significant number of physicists find problems in this field worth pursuing, perhaps a greater portion of time in the introductory course should be spent introducing students to concepts useful in condensed matter physics. This is not to say that we should let the market drive our education system; the university is not a technical training school. In an introductory course we should, however, give a realistic representation of what it is that physicists really do and the type of problems physicists are competent to address. By including at least some relevant material from representative areas such as condensed matter in the introductory course we also do a service to the significant portion of students who will end up in that field by encouraging them to think about unsolved problems at the earliest possible point in their career.

This doesn't mean we have to completely revamp course descriptions and textbooks. (I suspect widespread resistance will make this impossible anyway.) I offer the following suggestions (most of which I am currently trying out) concerning the structure of the introductory course.

(a) Keep classical mechanics first (give them something tangible to hang onto at first) but cut back on rotational dynamics, introduce modern topics and applications (some condensed matter physics for example) as the course proceeds, where they fit in.

(b) Spend a lot more time on waves, wave equations, and wave phenomena.

(c) Include material that relates to the nonphysics major: Schrödinger's equation for chemists, transistors for computer scientists, etc.

(d) Cover electrical circuits in the laboratory rather than in lecture.

(e) Cover statistical mechanics rather than classical thermodynamics. (Thermodynamics is thoroughly treated in chemistry courses anyway.)

(f) Use the computer *only* as a peripheral tool and only where it makes an impact, for example: data collection in an experiment that can't be done any other way; simulation of something that can't be easily visualized; simple numerical programing (a chaotic system for example). Keep in mind that physics is *not* a video game. Computers are only a means for reaching the goal of understanding the physics.[6–8]

(g) Assign some reading and writing (we do a lot more writing than we care to admit). Have students analyze and write about a *Scientific American* article for example. Ask a few thought problems requiring no math on exams.

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[1] *Report on the National Science Foundation Disciplinary Workshops on Undergraduate Education*, L. M. Lederman, Chair of the Physics Workshop (National Science Foundation, Washington, DC, 1989).

[2] G. J. Aubrecht II, "Redesigning courses and textbooks for the twenty-first century," Am. J. Phys. **57**, 352–359 (1989).

[3] A. A. Bartlett, "Role, mission, and change in our introductory collegiate physics courses," Am. J. Phys. **56**, 204–209 (1988).

[4] *Entry-Level Undergraduate Courses in Science, Mathematics and Engineering: An Investment in Human Resources* (Sigma Xi; The Scientific Research Society, Triangle Park, NC, 1990).

[5] G. J. Aubrecht II, D. F. Holcomb, and W. C. Kelley, Eds., *Education for Professional Working Physicists* (AAPT, College Park, MD, 1986).

[6] D. Harrison and J. M. Pitre, "Computers in a teaching laboratory: Just another piece of apparatus," Comput. Education **12**, 261–262 (1988).

[7] E. F. Redish and J. S. Risley, Eds., *The Conference on Computers in Physics Instruction Proceedings* (Addison-Wesley, Redwood City, CA, 1990).

[8] R. C. Nicklin, "Faraday's law—Quantitative experiments," Am. J. Phys. **54**, 422–428 (1986).

THE FEYNMAN SPRINKLER

In 1989 I wrote a paper dealing with the inverse sprinkler puzzler posed by R. P. Feynman in his book, *Surely You're Joking Mr. Feynman*. In good conscience I submitted the manuscript to the American Journal of Physics and received an acknowledgment of its receipt on 8/21/89. I then received a letter dated 9/7/89 from Robert H. Romer which said:

> I have been thinking about your manuscript on Feynman's sprinkler (manuscript number 1523). I am afraid that it is time for *this* Journal to declare a moratorium on publications on Feynman's sprinkler problem. As you know, there have been several that have appeared in print, not all of them in agreement with one another. There are several others that are in the works at the present time. I think that in view of the rather small number of physicists who are in fact interested in this problem (though, I grant you some of those who are interested are passionately interested) I would rather not publish more on this subject.

There was no mention by Mr. Romer of the quality of the physics in my paper as having figured in its rejection.

Imagine my outrage when I looked at the April 1991 issue of Am. J. Phys. and saw an article dealing with the Feynman sprinkler problem. The article had been received on 2/21/90 by Am. J. Phys., exactly six months after my paper was rejected. I was never notified of the lifting of the Romer imposed moratorium. Perhaps it is selectively applied or the rules of its application are secret. I think this arbitrary and inconsistent policy of the editor is unconscionable.

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PLANCK'S POSTCARD TO WEISSKOPF

You recently published as an AJP page filler[1] an excerpt from a 1976 lecture by Victor Weisskopf, in which Professor Weisskopf, my longtime neighbor, told the heartwarming story of how in 1923, as a boy of about 15, he had the chutzpah to write to Max Planck, asking him please to explain waves, particles, and the quantum theory. And Planck replied, on a handwritten postcard. What an impression that made on young Viki, to be "taken seriously by one of the greatest physicists of the time." "Unfortunately," said Weisskopf in 1976, "that postcard was lost in my many trips, and I regret it very much."

The postcard has been found! I am sure you and your readers will be pleased to learn that Weisskopf's recently published autobiography[2] contains a photograph of the postcard (actually dated in 1922), together with a helpful translation for those, like me, whose supposed mastery of German has been monotonically declining since the moment a kind and sad professor declared that we had passed our graduate school language examination. That Planck's reply, written in 1922 before Heisenberg and Schrödinger, was not quite correct, as Weisskopf points out, does not diminish the importance of this interaction between two of this century's greatest physicists: "I now every time, religiously, when I get a letter from a high school kid, I answer it. I know what it meant, although I am not Planck, but I know what it meant, and I'll never forget that. This certainly was one of the reasons why I decided seriously to get into physics."

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1 September 1991

[1] Victor F. Weisskopf, "Weisskopf and Planck," Am. J. Phys. **59**, 778 (1991).

[2] Victor F. Weisskopf, *The Joy of Insight: Passions of a Physicist* (Basic Books, New York, 1991), Fig. 1 and p. 3.