



Stretch Your Dollar!

As your budget gets tight, every dollar needs to stretch further and further. Sometimes painfully far.

Call us.

We'll help you stretch your dollar in the right direction — the direction of value. At McAllister Technical Services we make equipment specifically designed for you — from our well-known Scanning Tunneling Microscopes, Tribological Systems, Chambers and Fittings, to our Electron Energy Loss Spectrometers, Catalytic Reactor Cells, Custom Hemispherical Analyzers, Crucibles and countless other custom-made Gizmos. Imagine, such exceptional quality for a price that will stretch your dollar further than you dreamt possible. Painlessly.

We'll make your dollar go the distance—guaranteed. Call 1-800-445-3688 for more information.

McAllister Technical Services

Manufacturers of surface analytical instruments and devices

West 280 Prairie Ave.
Coeur d'Alene, Idaho 83814
FAX (208) 772-3384

Circle number 50 on Reader Service Card

A Physicist's Desk Reference

The Second Edition of *Physics Vade Mecum*
Herbert L. Anderson, Editor-in-Chief

1989. 356 pages. Index.

Hardcover. ISBN 0-88318-629-2.

\$70.00 list price. /\$56.00 member price.*

Paperback. ISBN 0-88318-610-1.

\$45.00 list price. /\$36.00 member price.*

An updated and expanded edition of the bestselling *Physics Vade Mecum*, **A Physicist's Desk Reference** is a compact, comprehensive storehouse of the most useful information, formulas, numerical data, definitions, and references grouped by discipline. The recompiled index is more than twice the size of the original and affords even more efficient use of this quick-reference tool. Designed for fast and easy access to data with minimal searching, **A Physicist's Desk Reference** saves time and effort in solving a wide range of scientific and technical problems.

Available at Select Bookstores!

Or Call Toll-Free 1-800-445-6638

(In Vermont 802-878-0315).

AIP American Institute of Physics
Marketing and Sales Division
335 East 45th Street • New York, NY 10017-3483

* Member rates are for members of AIP's Member Societies and are only available directly from AIP. To order books at member rates, please use the Toll-Free number.

Prices are subject to change without notice.

3/91

them how experiments could help provide answers.

What is not required for pre-college physics? We do not need teachers who have, think they have or think they ought to have all the answers. We do not need science curriculums that seek to convey a wide range of physical principles. We do not need to develop pre-college physics programs that strive to turn out students who can readily solve textbook physics problems. With the right sort of pre-college education, principles and problem solving will come readily later, at the college level.

KEN DRAGOON

Bonneville Power Administration
10/91 Portland, Oregon

I greatly enjoyed reading the excellent article by Jose Mestre on introductory physics teaching using the constructivist approach.

With superb teachers, more students would gain insight under that new system. However, in the real world, average teachers frequently would not have sufficient background to focus the interactive questions of the constructivist classroom on precisely the important aspects of the problems. I fear that the best students might then be hampered in their stumblings toward insight, while the lesser students would not be helped anyway. Let us remember the "new math" of a few years ago.

Given the bleak picture Mestre paints of the traditional approach, how were so many of us able to gain insight? When I think back on how my cohorts and I learned science from the traditional approach, I find that the presentations were indeed dry, absolutist and so on. But after a while some students suddenly noticed the underlying patterns, said "Aha!" and made it—they became "Scientists." The rest just fumbled along.

In the absence of a preponderance of superb teachers, perhaps the maximum overall good might be served by continuing the present system. Yes, do encourage those teachers who are insightful and resourceful enough to use different systems, such as constructivism, to do so. But the attempt to force it on everyone could, I believe, result in a situation worse than the present one.

KURT NASSAU

10/91 Lebanon, New Jersey

How Do Students Get Misconceptions?

In his article "Learning and Instruction in Pre-College Physical Science"

(September 1991, page 56) Jose P. Mestre discusses in detail overcoming common misconceptions students have about physics. He illustrates several examples of such misconceptions in his figure 1, whose caption states, "Traditional instruction based on the 'transmission model' is often inadequate to overcome misconceptions." He does not point out, however, that many of our students' misconceptions have probably been *acquired*, in the course of successful "learning" by the traditional methods, from incorrect and misleading presentations in textbooks.

Mestre gives the example of students' believing that a ball shot through a level, spirally shaped tube will continue on a spiral path after emerging from the tube. This does not seem to be an unreasonable conclusion for students who have learned from their high school physics books that Newton's first law "states that a *net unbalanced force is needed to change the state of motion of an object*," to quote *Physics: Principles and Problems*, by Paul W. Zitzewitz and James T. Murphy (Merrill, Columbus, Ohio, 1990). The "state of motion" of the ball, after all, was clearly described as coming through the spiral tube.

The discussion leading to the above statement of Newton's law is not very illuminating either. The students are told to "consider an object that has no net force on it. If it is at rest, it will remain at rest. *If it is moving at constant speed in a straight line, it will continue to do so [italics added].*" It does not appear unreasonable that the students extrapolate such statements to "If it is in spiral motion, it will continue to move in a spiral." Why does the almost sensible statement have the restriction "*If the object is moving at constant speed...*"? There should be no concern with the details of the motion before the forceless motion is considered. Nowhere is there any indication that the forceless motion is a continuation of the *instantaneous* velocity of the object at the instant when forces on the object ceased. All the examples deal with initially constant velocity. It is a big step for the students to develop such generalizations on their own after they have seen so many confusing, although not incorrect, expositions.

Another of Mestre's examples of misconceptions concerns the explanation some students give for why, when two different kinds of light bulbs are connected in series to a battery, one is lit and the other is not. These students believe that the electricity gets

LETTERS

used up in one bulb before it gets to the other. This explanation is similar to a description in the teacher's edition of the sixth-grade volume of the series *Science: Understanding Your Environment* (Silver Burdett, Morristown, New Jersey, 1972): "In a series circuit [of presumably identical light bulbs] the lamps grew progressively dimmer, reading from the negative to the positive terminal." The emphasis on the fact that the bulb nearest the negative terminal is the brightest suggests that the authors want to convey the impression that electricity (or perhaps the negative electrons) is being used up.

MARIO IONA

University of Denver
Denver, Colorado

10/91

ZITZEWITZ REPLIES: Mario Iona might be correct that some students may interpret "state of motion" to mean the spiral motion of the ball when it is in the tube, and that some may believe that "If it is in spiral motion, it will continue to move in a spiral" is a correct generalization from the two "If..." conditions he cites. My experience with students, however, indicates that most of them read textbooks with much less care than we might hope—certainly not carefully or actively enough to produce such sophisticated, if incorrect, generalizations. The 1992 edition of our textbook makes neither of the statements Iona quotes. As Richard Gunstone and Michael Watts write, "Language which is meaningful to teachers may, because of students' views of the world, have a quite different (even conflicting) meaning for students. If we are not sensitive to this, we can unwittingly reinforce the very view we want to change."¹ Thus when cognitive scientists study student learning, they might include in their student interviews questions of textbook interpretation.

Many student misconceptions not only have obscure origins but also are extraordinarily difficult to overcome. My experience with trying to correct student misconceptions about electrical circuits—specifically, the idea that a battery produces a constant current—shows that even university students find it very difficult to integrate what they have learned in separate contexts. On an examination in my engineering physics course, over 40% of the students stated that if the current in one branch of a parallel circuit is decreased, the current in the other must increase to compensate—this despite a clear textbook discussion of the independence of currents in the

branches, completion of problems calculating currents, a demonstration showing the independence, and a laboratory exercise where students measured the current in one branch while changing the current in another.

As Jose P. Mestre describes in the box on page 59 of the September 1991 issue, overcoming student misconceptions requires not only correct and clear textbook expositions but an active teaching technique. All of us involved in teaching and textbook writing have an interesting and important challenge.

Reference

1. R. Gunstone, M. Watts, in *Children's Ideas in Science*, R. Driver, E. Guesne, A. Tiberghien, eds., Open U. P., Philadelphia (1985), p. 101.

PAUL W. ZITZEWITZ

1/92 University of Michigan, Dearborn

Reward Teaching as Much as Research

In the September 1991 issue (page 56), Jose P. Mestre presents a thought-provoking discussion of the "transmission model" and the "constructivist model," the main instructional practices found in American education today. If you recognize a degree of "constructivism" in your own career, then you are indeed fortunate.

That a "constructivist" teacher would need inordinate skill and talent goes without saying. Imagine leading students in discussions such as the example Mestre gives on page 58. That would require a fine touch, and not just for dealing with the technical aspects of science. In fact, a detailed knowledge of science may be less important than knowing when to insert the comment that maintains an appropriate atmosphere of inquiry. Experience suggests that constructivist teaching is the most effective—but what would motivate someone to expend the enormous effort needed to develop the requisite skills?

Years ago, teachers (never an economically advantaged group) were deemed sufficiently necessary to deserve some security. This was particularly true for those who taught tenets unwelcome in the political climate of their day. Thus arose the concept of tenure. In effect, society admitted that certain services were important and needed to be protected and nurtured. Currently, tenure decisions are not based solely on teaching. Often it seems that research credentials and grantsmanship are primary. Some cynics might suggest

PARTIAL DIFFERENTIAL EQUATIONS SOLVER

by



SPDE applies advanced techniques of numerical analysis to the solution of problems in engineering and science.

SPDE will solve a large class of linear and non-linear systems that can be expressed as two dimensional boundary value problems.

SPDE will run on any 386/486 computer running MS-DOS with a minimum of 2Mbytes of RAM and 3 Mbytes of free disk space.

SPDE requires no knowledge of advanced programming or detailed methods of numerical analysis.

SPDE is affordably priced.

for more information contact

SPDE, Inc.

40580 Saddleback Rd., Bass Lake CA 93604

FAX: (209) 683-8611

(800) 831-SPDE

Scientific/Engineering Software & Hardware Solutions

Circle number 52 on Reader Service Card

MEASURE & CONTROL RESISTANCE & TEMPERATURE LOW SENSOR POWER



LR-400

AC RESISTANCE BRIDGE 4-WIRE AUTO-BALANCE

- IEEE-488 (NEW)
- Continuous variable excitation (new)
- 8 ranges .02 Ω to 200K Ω
- 1 micro-ohm resolution
- 4 1/2 digit display
- 4 1/2 digit set resistance
- R, Δ R, & 10 Δ R modes
- Low noise
- Mutual inductance option
- Drives our LR-130 Temperature Controller

LINEAR RESEARCH INC.

5231 CUSHMAN PL. X21
SAN DIEGO, CA 92110

PHONE: 619-299-0719

FAX: 619-299-0129

TELEX: 6503322534 MCI UW

Circle number 54 on Reader Service Card