

late further work that could dispel any doubts that might remain about these strange effects. The high resolution that can be achieved with the scanning electron microscope should make it possible to achieve much greater accuracy in measuring hardness using a diamond indenter and eliminate the subjective factors that appear to have influenced the earlier investigations.

To Yasuo Nannichi I extend greetings, along with assurance that I have no difficulty believing that the high density of injected carriers and their recombination radiation can contribute to dislocation motion and degradation during the operation of semiconductor lasers.

Kyle Forinash and William D. Rumsey question the accuracy of the transcription of Langmuir's lecture. As stated in the introduction to the PHYSICS TODAY article, a copy of Langmuir's talk is on file with the Whitney Library of the General Electric Research and Development Center in Schenectady, as a cassette tape. Those interested are more than welcome to listen to it and satisfy themselves as to the accuracy of the version published in PHYSICS TODAY.

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ROBERT N. HALL
2/90 Schenectady, New York

Rehabilitating Romania's Research

I recently received a letter (dated late January 1990) from fellow physicists working at the Institute of Physics of the Romanian Academy of Sciences, on the outskirts of Bucharest. I was, of course, relieved to learn that personnel and facilities (for what they are worth) survived the dramatic and unexpected upheaval of late December relatively unscathed. Anyone who has visited Romania in the past decade undoubtedly shares with me a feeling of admiration for the dedication and determination shown by some of our colleagues in Romania, who strove to continue their research under incredibly dire circumstances, physical, financial and intellectual. These facts are, however, not the point of this communication. I wish instead

to forward an appeal for assistance from my Romanian friends. They write:

In the past year, the Security censorship became so effective that all our correspondence was stopped. Please be so kind as to send us information about [a specific conference] and any other conferences which are being held in the next year or so. We believe that we will be able to attend in the future.

We are entering now the most difficult part of our revolution: building. This is why I... request: If you know any laboratories which have some equipment they wish to get rid of, please ask them to contact me: Dr. V. Lupei, Institute for Atomic Physics, Romanian Academy of Sciences, 76900 Bucharest—Magurele, Romania.

We are in need of almost everything: equipment for lasers, detection and signal processing, computers, oscilloscopes, spectrometers and so on, even typing or copying machines, books and journals.

I suspect that they are not in a position to defray shipping costs; nevertheless, it seems to me that our community has an opportunity to make a humanitarian gesture by answering this appeal, even in some minor way. Their needs are real, and time has come to reintegrate our Romanian colleagues into the greater scientific community. I assume that this also the case with other Eastern Bloc nations. Please feel free to contact me if you have any comments, suggestions or questions.

WILLIAM M. YEN
Department of Physics and Astronomy
University of Georgia
2/90 Athens, GA 30602

Contributions of a Nobelist's Colleagues

I very much appreciated the excellent review of the work of the three 1989 physics Nobel laureates (December, page 17), especially because my thesis research at Columbia in molecular beams brought me into contact with Norman Ramsey's and Wolfgang Paul's contributions and because my long association with the University of Washington has made me a witness to the remarkable development of particle-trapping techniques by Hans Dehmelt. In all but one instance I believe proper acknowledgment was given to Dehmelt's colleagues who have partici-

pated with him in this development.

The exception is related to the idea of Dehmelt's termed the "quantum jump" in the Royal Swedish Academy's press release or the "shelved optical electron amplifier" in the PHYSICS TODAY news story, an idea central to realizing, in a practical way, the incredible precision inherent in the measurement of an optical frequency of a stored ion. In all his recent ion work as well as in the first observation of a quantum jump (*Physical Review Letters* **56**, 2797, 1986) Dehmelt has benefited from a collaboration with his colleague Warren Nagourney. In the quantum jump work cited he also had the assistance of Jon Sandberg, then a University of Washington undergraduate. A history of ion-trapping development would not be complete without these two names.

MARK N. McDERMOTT
University of Washington
2/90 Seattle, Washington

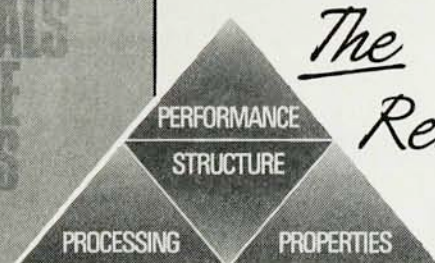
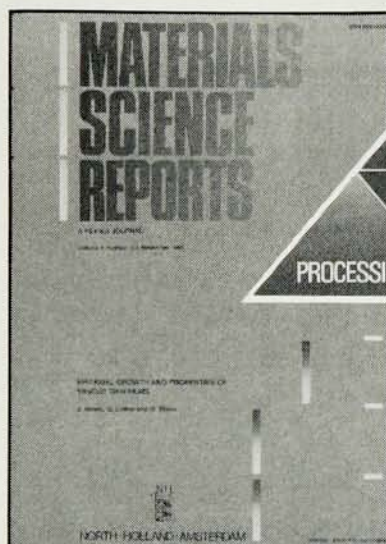
DEHMELT REPLIES: Given *in toto*, the citation in my colleague Mark McDermott's letter would read, "Warren Nagourney, Jon Sandberg, Hans Dehmelt, 'Shelved Optical Electron Amplifier: Observation of Quantum Jumps,' *Physical Review Letters* **56**, 2797 (1986)," and I fully agree with the contents of the letter.

HANS DEHMELT
University of Washington
3/90 Seattle, Washington

Why Few Take Physics: Educated Guesses

The AIP-AAPT high school physics teacher survey (August 1989, page 30) points up the education problems of our profession. The results should not surprise us, for they are a consequence of the priorities of nearly every PhD-granting physics department in the country: research at the top, followed by doctoral dissertations, graduate courses and undergraduate physics major courses. At the bottom are the introductory courses for science and engineering students and perhaps, if the department is especially broad-minded, a course for the remaining 80% of the student population.

The course for nonscientists, if offered at all, is not taught by those physics faculty members who aspire to publications and tenure. This is the "watered down" physics course, generally a boring image of "real" physics—that is, of the courses that have lots of equations and problems on such fascinating topics as blocks on



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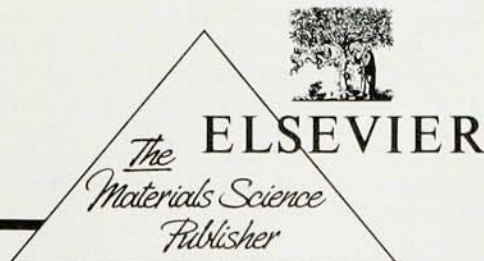
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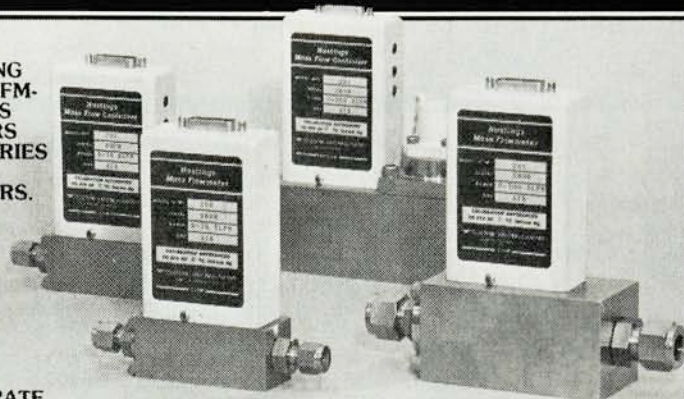


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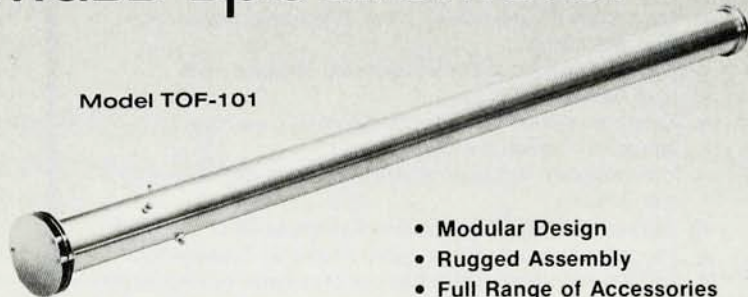
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inclined planes. This course still has blocks and inclined planes, but with simpler math. It is the only physics course that the teachers and parents who will determine the next generation's attitude toward science will ever see.

We must devote much more attention to teaching the future teachers and the public. At the college level, we must offer relevant physics rather than watered-down professional courses.

At the high school level, my recommendation is to teach a nonmathematical (numbers and graphs, but no algebra) first course in physics that focuses on the qualitative meaning of the great physics principles along with their connection to the physics-related topics that really matter, such as energy resources, nuclear war, the greenhouse effect, space travel, the meaning of modern physics and, especially, the scientific method. A lively and realistic laboratory experience, emphasizing data collection, intelligent guessing, the role of theory, statistical analysis, estimation, probability and experimental errors, should be included. It should come in 10th or 11th grade, assume no mathematical preparation and be taken by every American. Properly taught, it would rectify many of the problems described in the AIP-AAPT report. Prospective science students could then go ahead, in 12th grade, and take today's traditional college-prep physics course.

Until we take our educational responsibilities seriously, we physicists have primarily ourselves to blame for the sordid facts detailed in the report.

ART HOBSON

University of Arkansas
Fayetteville, Arkansas

8/89

Re Michael Neuschatz's article on high school physics education: It is commendable that AIP does not lose sight of this important topic. I cannot resist pointing out a convoluted sentence from the article, written in true scientific tradition: "While these findings by no means provide definite confirmation for the notion that broad physics literacy and the education of professional physicists are complementary goals, the findings do supply tantalizing suggestions for further investigation." But do we need further investigations to tell us that if we teach more physics there will be more physicists?

We all know (or should know by now) that the entire high school curriculum is at or below third world standards. There are good teachers and good students, but they all have

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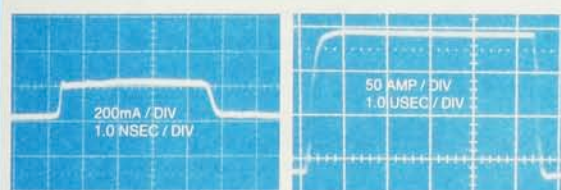
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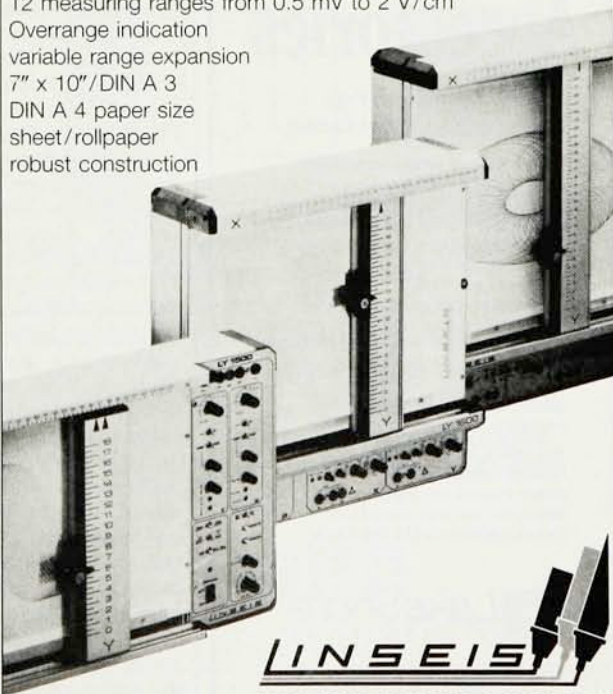
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to operate in an environment that makes essentially no demands on the student. How else can you have near-illiterates with high school diplomas? How can a student not know that $\frac{1}{4}$ and 0.25 are equal and yet graduate from high school?

If we recognize the simple truth that scientific literacy will be a survival skill for the next century, we will be forced to respond appropriately. The simplest way to make physics and science education more widespread is to require it of all students. Furthermore, the students should have to pass exams in which the possibility of failure and repeating a grade is real. This is the way most or all of the other countries cited in the article operate. We can spend millions on studies, better salaries, facilities and so on, and it will all be wasted if we are not willing to face up to two simple truths: that critical topics must be required, and that minimum standards of performance must be set by examinations. In my view, AIP should first seek a consensus on this and then actively promote the idea.

Instead of further arguments, here is the curriculum that I had to follow in the last three years of high school in Greece, as best as I can recall. A quick comparison with the US curriculum is all that is needed to appreciate our current problems:

▷ Grade 10—Modern Greek and Literature, Ancient Greek, Mathematics, Concepts of Physics, Biology, Geography, French, History, Religion, Drafting, Music.

▷ Grade 11—Modern Greek and Literature, Ancient Greek, Algebra, Plane Geometry, Trigonometry, Physics, Inorganic Chemistry, Religion, Introduction to Psychology, French, History.

▷ Grade 12—Modern Greek and Literature, Ancient Greek, Advanced Algebra and Introduction to Calculus, Three-Dimensional Geometry, Trigonometry, Physics, Organic Chemistry, Ethics, Logic, French, History.

All topics were required of all students. The only concession was that arts-oriented students devoted fewer hours to science and took Latin and more arts. There was a comprehensive examination at the end of the school year, as well as a comprehensive midterm. If you failed up to two topics, you had a second chance in early September, before the new school year. After that, a grade of F in any one course (except drafting, music and French) meant repeating the entire grade.

As an ironic footnote, Greek high schools are now beginning to produce

near-illiterates at the same rate as the American schools. This happened only a few years after the system was modified along the lines of the American system, with electives, fewer courses and fewer demands on the students. Do we really need any further proof?

PANPAZIS MOUROULIS
Rochester Institute of Technology
Rochester, New York

8/89

My husband is the physicist in our family, but with our oldest daughter starting school, I read your article on high school physics enrollment. Perhaps my experience will be of interest.

In 1972-73 I took advanced placement high school physics, which consisted of a small group of students working on their own without direct supervision. I was the only girl in the group, an intimidating situation at that age. In addition, the boys' background seemed to provide them with significant experience in lab work; mine did not (the basic dolls vs erector sets problem). With only limited teacher involvement, I had no opportunity to learn how to perform and analyze experiments.

Ultimately I received advanced placement, but when I took my next physics class, in college, I found my background was spotty, and I ran into the same problem of translating theory into lab work. Because there was no mechanism to help me bridge this gap, I became increasingly frustrated and lost. Finally I dropped the class.

While my experience hardly constitutes a scientific survey, it does suggest two ideas:

▷ There may indeed be a "critical mass" in high school physics when it comes to underrepresented minorities. Instead of trying for incremental increases in their enrollment, we might find a major push over a short period to be more self-sustaining.

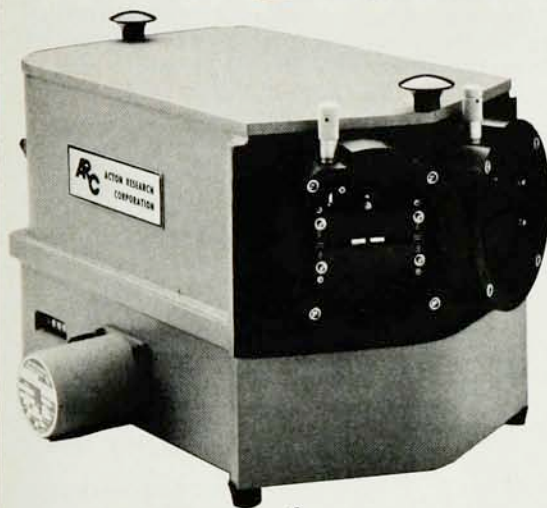
▷ More importantly, I suspect the emphasis on math as a deterrent to learning physics may be misplaced. I earned A's in three semesters of calculus. It was not problems with math but difficulties with thinking experimentally that deterred me. This difference may help explain the mixed results obtained in attempts to correlate math ability with enrollment in physics.

Though I ended up graduating in economics, I never completely gave up my interest in physics. As a freelance writer I've sold several articles about physics to children's magazines. Perhaps I can influence the next generation.

MARLYS G. STAPELBROEK
Santa Ana, California

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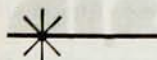
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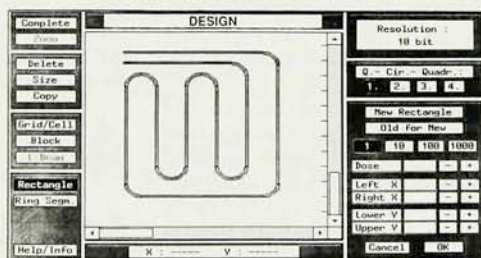
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NEUSCHATZ REPLIES: My article suggested that at least some of the causes of low physics enrollments in the nation's high schools are deeply rooted in our social structure and relate to the way our educational system distributes opportunities to different groups of students. To the extent that this is true, the potential for achieving meaningful improvements by relying mainly on the type of regulatory changes advocated by Panpazis Mouroulis would seem to be severely limited. As things stand now, the choice of whether or not to take physics has been largely left up to the students, and they have, as the saying goes, "voted with their feet." Before we decide to change things by abolishing their right to choose, it would be instructive to examine why they have chosen that way.

Art Hobson points out one reason: Our high school classes tend to be watered-down versions of higher-level courses geared to training future science professionals. This provides little incentive—especially in our "career oriented" times—for those who are not planning to become professional scientists. Introducing physics earlier (as is done in many other countries) and with a somewhat less mathematically oriented approach might serve two functions—to make it accessible to more students, and to interest more of them in proceeding to the standard 12th-grade preprofessional course as it is now taught. Such an approach has recently been advocated by the National Science Teachers Association.

Marlys G. Stapelbroek has pointed out another reason why so few are now choosing to take high school physics: We have been especially bad at engaging the approximately two-thirds of our students who happen to be female or members of minority groups. In the case of women, the culprits include early socialization and the continuing presence of overt and covert sexual discrimination in the education system and the job market. While there has been a bit of improvement in recent years, it is still the case that a disproportionate number of even those women with above-average scores on math aptitude and achievement tests avoid fields like physics and engineering, where math is applied to real-world situations. In the case of minority groups, socialization and discrimination combine with the legacy of generations of real economic deprivation to steer most students away from the "academic track" (and thus the sciences) entirely.

Simply converting from an elective to a mandatory standard without

reshaping the curriculum is likely to result either in masses of alienated students sitting in physics class (perhaps two years in a row) and learning little, or in the introduction of poorly watered-down versions of the current course—the physics equivalent of Business Math, if you will. Neither outcome is desirable. Real change is possible, but it will not come cheaply. If we want all citizens or all workers to be scientifically literate, we will have to stop relying primarily on courses that were designed to promote preprofessional training.

MICHAEL NEUSCHATZ
American Institute of Physics
3/90 *New York, New York*

Renaming OSA: Proposal Opposed

The January issue of *PHYSICS TODAY* carries on page 68 a news story regarding a proposal to change the name of the Optical Society of America. However, the story does not give any indication that views of the membership on this issue were not solicited and that many well-known members of the society, including some of its honorary members and past presidents, strongly oppose the change. Nor does the article mention that the very procedure of ratifying the proposal is in dispute or that the recent renaming of the society's magazine *Optics News* to *Optics & Photonics News* was done without consultation with the magazine's editorial advisory committee.

EMIL WOLF
University of Rochester
1/90 *Rochester, New York*

Small Grants for the Unsupported Scientist

It is a truism of human nature that there will never be enough research funding to satisfy all reasonable claimants. However, the current system has flaws that can be remedied without a utopian increase in Federal support. At present it is difficult for young scientists who have never been funded or scientists in mid-career whose funding has been terminated to obtain any support at all. Many physicists are affected. They are unable to pay page charges, travel to meetings or purchase even inexpensive laboratory supplies and equipment; the research of these scientists, many of whom are quite productive, is also disrupted by a frenzy of grant writing and attempts to wring support from any conceivable source,

however implausible.

I suggest a partial remedy: Let the NSF establish a program of small grants (perhaps \$10 000–\$15 000 annually, with no overhead permitted) awarded only to scientists with no other support. These would be sufficient to pay for summer salary, page charges, travel and modest experimental supplies. The money would be drawn from existing programs; because it would be divided among smaller grants, many more could be awarded. Proposals would be brief, and would be judged on the basis of a description of past accomplishments, thus freeing the proposer from the need to tailor the proposal to the presumed interests of the reviewers or to defend against the natural skepticism aroused by any new or venturesome idea.

JONATHAN KATZ
Washington University
3/89 *St. Louis, Missouri*

Advice for Apartheid- Conscious Academics

I visited Johannesburg for five weeks in the summer of 1989, with financial support from the Foundation for Research and Development at the Council for Scientific and Industrial Research (Republic of South Africa), to engage in collaborative research with colleagues in the department of physics at the Rand Afrikaans University. My visit was scientifically productive as well as touristically interesting. I gave seminars at RAU and presented a paper at the annual meeting of the South African Institute of Physics in Pretoria. I also visited churches and community projects in the black townships of Soweto and Tembisa, the diocesan offices of the Anglican cathedrals of Johannesburg and Capetown (which are largely concerned with social issues), and social agencies, like Detainee's Aid, dealing with problems originating in apartheid.

I was naturally concerned lest my visit weaken the effect of sanctions against South Africa supported by some of my colleagues and intended to persuade the government to terminate its apartheid policies with all due speed. I now believe, however, that the net effect of my visit, even within the limited framework of my academic interactions, will have been to support efforts against apartheid, in whatever small degree. Almost all the academics I met, especially at Witwatersrand University, which is fully integrated, are unhappy with the policies (though some would claim that they are changing quite rapidly