all. We must find ways to profit from the former effect and eliminate the latter.

I don't disagree with Wigner about the importance of other disciplines, such as economics, the arts, languages, music and so on. I just think this is not the time to slow down on the production of physicists or the development of physics.

STEPHEN M. SHAFROTH
The University of North Carolina
Chapel Hill, North Carolina

Bootleg bombs

Richard Wilson's review of *Nuclear Energy: Its Physics and Social Challenge* (by D. R. Inglis) in the November issue (page 47) contains an important error. Specifically, Wilson contends that Inglis has overstated the problem of diversion of nuclear fuels by failing to point out that "Plutonium has to be a pure isotope (Pu^{239}) to make a bomb and that plutonium produced in most power reactors will be diluted with other isotopes and must be isotopically separated to make a bomb."

Unfortunately, this is not the case. It is true that plutonium produced in today's light-water reactors contains as much as 20–30% Pu^{240}, but this "reactor-grade" plutonium can nevertheless be fashioned into formidable bombs without isotopic separation. The presence of the prolific neutron emitter Pu^{240} renders the bomb maker's task more difficult and the explosive yield less predictable than is the case with pure Pu^{239}, but the resulting weapon is likely to be more than adequate for the purposes of terrorists, blackmailers, and even for some military applications. This conclusion has been stated emphatically in the unclassified literature by authorities in the weapons field.[1,2] One need not even transform the plutonium oxide found in most reactor fuels to plutonium metal—the oxide will do as it is.[1]

Many people may also be unaware of how large the quantity of material to be safegaurded will be in an expanded nuclear-power program, even if breeder reactors are not deployed at all. A large (1000 MWe) contemporary burner reactor of the light-water variety has an *output* of 220 to 285 kg of plutonium per year, versus 250 to 500 kg per year for a liquid-metal-cooled fast breeder reactor of the same capacity.[3] The breeder's plutonium is "better" bomb material than that from the LWR—it contains less Pu^{240}—but the difference is only one of degree, as noted above.

Wilson suggests, rightly, that an attempt be made to compare the hazards of energy alternatives—to weigh the potential consequences of dam failures, LNG explosions, and so on against the potential consequences of missteps with nuclear fission. Although large numbers of immediate deaths could indeed result from accidents with a variety of energy technologists, a liability that may be unique to fission is the potential for a legacy of environmental contamination and genetic damage far outliving the generation that makes the mistakes.

JOHN P. HOLDREN
University of California
Berkeley

References

1. D. V. Hall, "Adaptability of Fissile Materials to Nuclear Explosives," in *Proceedings of Symposium on Implementing Nuclear Safeguards,* Kansas State University, 25–27 October 1971; Praeger, New York (1972).
2. T. B. Taylor, "Diversion by Non-Governmental Organizations" in *International Safeguards and Nuclear Industry,* (M. Willrich, ed), Johns Hopkins Press, Baltimore (1973); page 181.
3. US Atomic Energy Commission, *Potential Nuclear Power Growth Patterns,* WASH 1098, US Government Printing Office, Washington, D.C. (1970).

CORRECTION: The sense of Wilson's review was altered by omission of the adjective "efficient" applied to "bomb." Thus the next-to-last sentence of the third paragraph should read: "Nor is it clear that plutonium has to be a pure isotope (Pu^{239}) to make an *efficient* bomb and that plutonium produced in most power reactors will be diluted with other isotopes and must be isotopically separated to make an *efficient* bomb."

EDITOR

New math critic

As an answer to J. S. Huebner's observation that the decline in physics enrollment has occurred at a time that suggests it might be related to the introduction of the "new math" into the public schools, I wish to suggest the following:

The introduction of set theory as a frame of reference for the teaching of all math courses, from kindergarten on, means that a student learns set theory every semester—with applications to the various subjects such as addition, multiplication, algebra, geometry, and so on. The students are therefore burdened with carrying along throughout their entire school career a subject easily mastered in one semester at the college level and of interest mainly to the theoretical mathematician and not to the physicist or engineer. This burden

is repetitious and confusing, and it interferes with the students' understanding of and interest and proficiency in the separate fields of mathematics and their applications.

A second consideration is that the "new math" books have been designed for the purpose of educating the average student who would not have been able to grasp the subject as the "old math" was taught. The material has been simplified, spelled out and made repetitious to such an extent that the naturally talented student *must* lose interest. Thus these students are not recognized by their teachers, and many high IQ (160 to 170) are lost in the so-called "slow" classes.

An additional factor, and perhaps the most important (in California, at least), is the practice of sorting out the students according to their supposed intellectual capabilities when they are in the third grade. The students are separated into several categories, which are then labeled ranging from "bright" to "slow." The students labeled "bright" in this way are given the most talented teachers, most advanced curriculum and the most outside enrichment for the rest of their school careers. The students labeled "slow" receive the leftovers. These decisions are made at a time when mathematical ability cannot yet be recognized and are made primarily on the basis of reading ability by teachers who are not qualified to make decisions so critical to the students' future. Through misjudgements of these third-grade teachers, many potential physicists, engineers and mathematicians are undoubtedly lost to the higher education system, while those who do arrive show no interest in these fields.

P. K. Kirkwood
Pacific Palisades, California

Material shortage

In your April issue, which I have only just seen, there is a dispute about the situation in developing countries (pages 15, 77, and 79). It seems to me that both Michael Green ("material resources tend ... to be woefully inadequate") and Michael Moravcsik ("the surfeit of equipment there that stands idle") are right. In our own case, for example, we are well equipped (though not, we feel, a surfeit) with an ultrahigh vacuum plant, high and low-energy electron diffraction, an Auger spectrometer, a quadrupole mass analyser, an electron microscope with television chain and other major accessories and so on, but we were so desperately short of material resources, such as pure materials, chemical reagents, spare parts, photographic materials and electronic components, that there is a real danger that our experimental work will soon grind to a halt. And this is not the fault of bad planning on our part, so much as the result of a policy on the part of most funding agencies that prefer non-consumable over consumable purchases and the setting up of new projects over the maintenance of established groups.

J. A. Eades
University of Chile
Santiago, Chile

Sakharov's accusers

Your recent news story (November, page 69) reported that letters appearing in the Soviet press denouncing Sakharov's position were signed by scientists in great number (names added). Let me point out a fact that is probably unknown to your readers.

Let me assure you that I can tell from first-hand experience that those scientists had to sign these letters. They had no other choice unless they were willing to lose their jobs and be "separated" from their families.

I lived 15 years in the "Communist Paradise" and I *had* to sign things 180 degrees against my will and conscience.

Name on File

Physicist for Congress

In your editorial in November (page 88) you deplored the fact that there are no proper physicists in the Congress, and for that matter few in Congressional circles of any sort.

I thought that your readers would be interested to learn that a former student of ours, George Wayne Brown, is likely to run for Congress in the 7th Congressional District of Tennessee next year. His present occupation is Vice President for Academic Affairs at Union University, Jackson, Tennessee, and he teaches physics and astronomy part-time. His birthplace was also in the 7th District, which sounds helpful. My knowledge of Tennessee politics is slight, but I know that Brown would not go into a time-consuming and laborious campaign unless he felt there was some possibility of success. Brown finished his PhD in astronomy in August 1970. His research and publications are in radio astronomy; he is well grounded in physics.

I surely agree with the sentiments expressed in your editorial, and I hope we can find ways to assist well trained physical scientists like Wayne Brown in the commendable effort of trying for a seat in the House of Representatives.

Stanley S. Ballard
University of Florida □