"experts" of the AEC laboratories. This was a perpetuation of the public awe at the sudden ending of the war with Japan at Hiroshima and Nagasaki. Today, ever since the dissolution of the AEC, nuclear-weapons design specifications continue to be determined by the "experts," as described by Dewitt.

Barker's statements about "modernization" vividly illustrate that one of the highest-priority specifications imposed on the nuclear-weapons designer is that the design must fit a given "delivery vehicle," many of which undergo large accelerations and temperature changes, as well as space limitations. An extreme example is the shell of the 8-inch self-propelled cannon pictured in Dewitt's article.

These challenging specifications have been successfully met by the nuclear-weapons designers, but one must still question the relevance of their clever solutions to national security needs. We are told that the resultant designs have short stockpile lifetimes; thus constant redesign or replacement of the nuclear-weapons stockpile is required. One is reminded of the Red Queen in Lewis Carroll's "Through the Looking Glass," who ran as fast as she could just to stay in the same place. Were the highest-priority specification to be changed to long stockpile life, it could reduce the required number of nuclear tests because the replacement rate would be lowered. It would also lead to different nuclear-weapons designs that would impose specifications in the opposite direction—namely, specifications on the delivery vehicles. For example, the cannon mentioned above could be replaced by a rocket. From the viewpoint of the nation's security, the relaxation of tension due to a lower rate of nuclear testing may be worth the technical changes in the designs of the nuclear warheads and their delivery vehicles.

The adoption of a comprehensive nuclear-weapons test ban would have similar effects. The highest-priority specification would then be that the weapons design could not be tested at all. More "conservative" designs would be drawn up, and delivery vehicles would have to be modified to accommodate them, but it would still be possible to build and maintain a nuclear-weapons stockpile, despite the change to a less exciting lifestyle for nuclear-weapons designers.

History shows several examples of nuclear-weapons designs that were accomplished without benefit of prior testing. The Hiroshima bomb was not tested before it was used. The first trial of the Nagasaki bomb design, the Alamagordo test, was successful. The first hydrogen-bomb test, at Eniwetok in 1952, was successful. Furthermore, the small nation of Israel has recently convinced the world that it has built a stockpile of nuclear weapons, without testing. In addition, present-day nuclear-weapons designers have access to the results of hundreds of past nuclear tests and to more elaborate computers than their predecessors had. They should have little trouble meeting the "no nuclear test" specification.

Whoever considers the effects of a comprehensive nuclear test ban should also keep in mind the history of the atmospheric test ban, which was stimulated by the fear of fallout. It certainly led to an immediate relaxation of tension, as if people thought it was a complete cessation of tests. If a real international comprehensive test ban is achieved, it will have a similar psychological effect. However, after several years people will begin to realize that nuclear stockpiles still exist, even without testing. The permanent relaxation of tensions will have to be sought in efforts to create world-wide toleration, understanding and cooperation. It all comes back to that: In the long run, a comprehensive test ban would only be a partial gesture, not a complete banishment of the nuclear-weapons threat.

JAMES W. SHEARER
Livermore, California
10/83

Med school: a bitter pill

I wish to reply to Mark Nedder's letter (October, page 15) on the value of a physics education, as my own experience has been somewhat different. About 7 years ago I came to the conclusion that research opportunities in my field of elementary particle theory were virtually non-existent (you could just about count the number of new tenure-track positions opening in the field per year on the fingers of your hands, and you'd have fingers left over), so I decided to study medicine. Besides the trauma of going back to being a student at the institution where I had been a faculty member, I found that the way of thinking in clinical medicine is totally different from that in particle physics. The practice of medicine involves principally a large amount of rote memorization: The treatment for this disease is this dose of that medicine, without a necessity for a real understanding of the reasons behind it, if they are known at all. Trying to attack these problems from a problem-solving orientation does not help at all, and I have found that my training as a physicist to think in this way has proven to be a significant hindrance. This is the case even though I have chosen the specialty of radiation therapy, where I would hope that my

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physics background would be most useful, and even though I plan eventually on a career in medical research.

I agree that a physics education is both enlightening and ennobling (and like Nedder, I maintain my APS membership), but one must still buy the groceries and pay the rent. While it is acknowledged that all PhD physicists will not be able to obtain employment in their field, it is assumed that most of them will be able to obtain engineering jobs in fields related to their area of training where they will be able to use their expertise. This is a good assumption for solving one's conscience, but there is no hard evidence that it is actually the case. We simply do not know what happens to those physicists who are forced to leave physics, but it is likely that many are forced to take rather menial positions for a person of their educational level. I would suspect that a physics education might prove even less useful to a taxi driver than to a physician.

ROBERT J. YAES
11/83 *Brooklyn, New York*

Scientists versus philosphers

The difference between scientists and philosophers, emphasized by Helier J. Robinson in "A theorist's philosophy of science" (March, page 24), can be accounted for by Darwin's theory of survival of the fittest.

Science survives better when airies and earthies cooperate, whereas philosophy survives better when they compete. Historically, at least, that would appear to be the empirical conclusion. Theoretically, it might be explained by noting that philosophy is largely thought, and it may actually progress better when philosophers jolt each other, as depicted on page 25. Scientists, on the other hand, are lured on by the mystery of the unknown, and need less prodding to stay on the right track.

From what is going on in the world, one would think that the leaders of nations are philosophers rather than scientists, and that there would be much more cooperation if scientists took over. Such a population inversion in Russia would place the refuseniks on top, and they would then undoubtedly cooperate completely in allowing the Kremlin to leave the country.

All roads lead to the March editorial (page 168), in a sense, when real thought is given to exactly why the refuseniks are not allowed to leave. Soviet strategists obviously fear that some of them may become Einsteins and Fermis, contributing to the defeat of the Soviet Union in war. This in turn implies that the Soviets contemplate war during the active lifetimes of the refuseniks, so there is great danger that World War III could start around 1990, fifty years after the start of World War II, consistent with the well-known theory that worldwide political and economic cycles tend to run in fifty-year periods.

Robinson may not have pointed out a weakness in philosophy (disagreement among earthies and airies may be its mainstay), but he may have pinpointed why world orders cannot be based on philosophical differences, and why scientists must cooperate (as on page 32) to achieve global harmony despite individual differences.

KENNETH J. EPSTEIN
3/84 *Chicago, Illinois*

Military strategy

As an ordinary citizen with only a very modest knowledge of foreign affairs, psychology of nations and military technology and strategy, I am finding it difficult to understand what the optimum policy for the US should be to avoid nuclear war and yet preserve our liberties. Many distinguished authors have written on the subject. All give highly convincing arguments for their theses, but disagreement among them is common. Each implies disaster if his recommendations are not followed. Consequently, it would be very helpful toward resolving confusion if authors would include, and editors would require, discussion of the following three subjects in any analyses:

Historical comparison. This is a form of experimental test of the proposed theory—imperfect, but the best realistic test we have short of implementation or catastrophe. Would a similar policy as advocated by the author have worked in an earlier era? (Of course adjusted for the era.) For example, would a weapons freeze have worked in the 1930s to contain the Nazis? Or, how often has disarmament helped the democracies? How often hurt them? Has excess armament by itself provoked war in the past?

Effect of proposals on adversary. Suppose the author's thesis is in fact adopted by the US. As a consequence, will our adversaries be more or less likely to cooperate toward reduction of tension and aggression? In particular, of course, will the Russians see disarmament, freeze proposals and so on as weakness and then be more likely to make new Afghanistans, Angolas, Ethiopias, Polands, Hungarys, Czechoslovakias, East Germanys, Estonias, Latvias, Lithuanias, Finlands and so on? Or, in contrast, will the Russians find our arming as provoking and dangerous to them and risk yet more

continued on page 71

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