The second consideration, which smacks of "political conservatism," is nonetheless founded on our Constitution—that is, that only problems found difficult of solution on local levels may be referred to the central government. The federal government should fill clear and present needs, where local authorities—state governments, universities—are not able to supply the requisites.

Perhaps the future of the intramural programs could be most satisfactorily sought in this second consideration. These programs could be directed toward problems where the strength of the federal government can fill a need beyond the capacity of weaker institutions. Let us do what we can, and let Uncle do what he must for all our benefit. There should be no competition, but rather complementation.

GORDON E. GREEN
School of Dentistry,
Temple University,
Philadelphia, Pennsylvania

Emotional Perils of Mathematics

People are turned aside from being mathematicians—by which I mean "pure" mathematicians—far more by temperament than by any intellectual problems. There are certain emotional difficulties which are intrinsic to the mathematical life, and only a few people are able to live with them all their lives.

First of all, the mathematician must be capable of total involvement in a specific problem. To do mathematics, you must immerse yourself completely in a situation, studying it from all aspects, toying with it day and night, and devoting every scrap of available energy to understanding it. You can permit yourself occasional breaks, and probably should; nevertheless the state of immersion must go on for somewhat extended periods, usually several days or weeks.

Second, the mathematician must risk frustration. Most of the time, in fact, he finds himself, after weeks or months of ceaseless searching, with exactly nothing: no results, no ideas, no energy. Since some of this time, at least, has been spent in total involvement, the resulting frustration is very nearly total. Certainly it seriously affects his attitude toward all other affairs. This factor is a more important hindrance than any other, I believe; to risk total frustration, and to be almost certain to lose, is a psychological problem of the first rank.

Next, even the most successful mathematician suffers from lack of appreciation. Naturally his family and his friends have no feeling for the significance of his accomplishments, but it is even worse than this. Other mathematicians don't appreciate the blood, sweat, and tears that have gone into a result that appears simple, straightforward, almost trivial. Mathematical terminology is designed to eliminate extraneous things and focus on fundamental processes, but the method of finding results is far different from these fundamental processes. Mathematical writing doesn't permit any indication of the labor behind the results.

Finally, the mathematician must face the fact that he will almost certainly be dissatisfied with himself. This is partly because he is running head-on into problems which are too vast ever to be solved completely. More important, it is because he knows that his own contributions actually have little significance. The history of mathematics makes plain that all the general outlines and most of the major results have been obtained by a few geniuses who are not the ordinary run of mathematicians. These few big men make the long strides forward, then the lesser lights come scurrying in to fill the chinks, make generalizations, and find some new applications; meanwhile the giants are making further strides.

Furthermore, these giants always appear at an early age—most major mathematical advances have been made by people who were not yet forty—so it is hard to tell yourself that you are one of these geniuses lying undiscovered. Maybe it is important for someone to fill in the little gaps and to make the generalizations, and it is probably necessary to create an atmosphere of mathematical thought so that the geniuses can find themselves and thrive. But no run-of-the-mill mathematician expects in his heart to prove a major theorem himself.

I wonder how much of this psychological difficulty is present in other scholarly fields. I suspect that no other field suffers so acutely from all four problems. The experimental sciences in particular, I think, are pretty well preserved from the second and third difficulties. An experimentalist can perform an experiment and, at the end, will have a set of data; and these data at least will indicate that such-and-such either is or is not significant. He knows before he starts the experiment that, except for equipment failure, he will finally have *something*. He is not faced with nearly certain frustration. Furthermore, publication standards permit experimentalists to describe details of procedures followed and difficulties encountered.

I also think the experimentalist has a reasonable hope for personal satisfaction. Experimental advances are frequently made by unknowns; in fact, there aren't many experimentalists in history who have consistently made important discoveries, if we don't count those who have been lucky enough to head active research organizations for long periods.

Whether other speculative disciplines are immune from the four emotional problems I've outlined isn't clear to me. But I feel that differing standards of precision may ease the problem of frustration, in the sense that it is often possible in these other fields to hide the fact that you don't have anything to say. A mathematician who says nothing in an obscure manner is usually caught quickly—but, alas, not always.

DONALD R. WEIDMAN
Department of Mathematics,
Boston College,
Chestnut Hill, Massachusetts

Force-Free Body: A Thought Experiment

Hanson's interesting essay, "Galileo's discoveries in dynamics" (29 Jan., p. 471), stresses the point that, even in a purely conceptual universe, a particle can never be totally free from unbalanced external force; therefore the law of uniform rectilinear motion (the law of inertia) can never, even in principle, be tested. This conclusion results from the evident need for a measuring rod, a clock, and an observer as the minimum furniture in an otherwise bare conceptual universe in order to demonstrate uniform rectilinear motion, but these material bodies exert an unbalanced gravitational force on the particle under test.