ism as a prerequisite. But this does not mean that they have to be combined in one course. That is what I am proposing for the high-school physics course. It should be a prerequisite for the college course.

2. What high mathematics is needed for Ohm's law? If the high-school students can't work that and the lens formula, why does the PSSC text introduce them to the differentiation of vectors (page 89)? Since none of the topics mentioned as possible choices requires as much mathematics as the typical noncalculus college courses, it is appropriate to have them mastered in high school. In addition, I suspect the mathematics is frequently learned better if there is an accompanying need for it. I would rather work to increase their mathematical skill than cut down on their depth of understanding in physics.

3. I think elementary calorimetry is more useful and practical than the sum of the particle theory of light, the quadrant electrometer and nuclear scattering (all PSSC topics). Rather, I think, the charge should be that the topics named in my letter are not exciting. Perhaps they are not exciting to the instructor, but I have seldom seen a high-school boy not "existentially involved" with how to determine that his car with x horsepower can get to 60 miles per hour in y seconds. You see, to the instructor it is the same old stuff, but to the student, it might be something he has wanted passionately to know for two years. The attitude of the instructor is much more important than the subject in this matter.

4. I suspect that the situation involving advanced-standing examinations is worse than Huntsinger says. But we do agree that at present any elimination of redundancy is the exception rather than the rule. However it would be interesting to see, in those cases where it is possible for the student to take advantage of a good high-school physics course, just how many of them only let him have the fun of relearning about the coefficient of friction once instead of the normal twice in college. On the other hand, consider what happens when the university gives a three-semester physics course with calculus. Usually for the first semester of the freshman year the student takes only mathematics. Then the physics starts off with velocity as the time derivative of the displacement. Are there any places like this that grant, say, credit for the first of the three semesters because of a good high-school physics course? I doubt that there are more than a very few. If all of this is true, colleges are not taking sufficient advantage of the physics taught in high school.

Alfred A. Kraus Jr
West Texas State University

Where to find values

Your December editorial "New values for old" contains its own most poignant comment: "Just what is wrong with our world we do not know, but we feel it is fundamental, basic, causal." Physicists, as scientists only, can not know what is wrong with our world, nor can we, functioning exclusively as scientists, do anything about it. Science has no means by which to provide the *ought* of personal relationships; it can only tell what is. Science's feeble efforts toward establishing ethical guides have all too often taken the form of identifying what ought to be with what is. The hope that the scientific demonstration of "the order of scientific law, the power of logical thought, the beauty of nature understood" will lead to "new values, new purposes and even new harmony for the world" is as completely chimerical as the hope that the writer so effectively deflates, that scientists can solve all man's problems because of their superior training and mental prowess.

As long as men, and possibly scientists in particular, do not recognize the dimensions of life that lie outside the confines of the scientific discipline, the dimensions of life that determine what men will do with technological advances, then only confusion can result in seeking for answers to the basic "wrongness" of our world. Unless a phenomenon can be described within the framework of space and time, it is not properly within the domain of science. Some scientists have indeed been unable to see why there should

be any domain outside of science, and therefore have concluded that there is no domain outside the natural world. But this is a philosophical conclusion and not a scientific one. According to its own definitions, science can say nothing about such subjects as God, beauty, love and faith.

The fundamental problem is not "a lack of new values to replace obsolete ones." It is the indifference to and the caricaturization of basic values in the presence of changing stimuli. R. Hobart Ellis Jr, who wrote the editorial, provides an example inadvertantly. The advance of science has not done away with faith in "protective providence," as Ellis seems to take for granted. The bestowal of scientific authority to such nonproofs is one of the elemental ways in which the interpretation of science has contributed to the modern dilemma about which Ellis is sincerely concerned. Can we not establish the basic truth that the understanding of a physical mechanism in physical terms does not in any sense constitute a complete and exclusive understanding? Is it not clear that the belief that the laws of nature are self-existing and self-sustaining is just as much an article of faith as the belief that God has created them and continues to sustain them? This kind of misinterpretation and misapplication of science constitutes the major nonproof active in weakening the ethical and religious foundations of human behavior. Nothing that science can uncover can in any way alter the basic relationship between man and that God to whom providence, justice, good, order and love have the same kind of deep personal meaning that they had long before Batman and the astronauts.

As to the "fundamental, basic, causal" wrongness of our world—let this be traced directly to the innermost quality of man, whether we call it pictorially his heart or his soul, which is characterized by unconcerned self-centeredness. Against the popular picture that man is suffering from some kind of spiritual sickness from which he can cure himself by good intentions and education, let us face the fact that the sickness in man is of the kind that will prove fatal unless he receives help from outside himself. It is a sickness that science can not touch, that is unassailable by the power of logical thought. It requires not a new outlook but a new beginning; not a new effort, but a new heart or soul that is freed from the limitations of self-centeredness.

My personal conviction is that such help has been made available to man by God in and through Jesus Christ.

Richard H. Bube
Stanford University

More about longevity

Thank you for the opportunity to comment on some of the letters received by PHYSICS TODAY about my article on life prolongation (PHYSICS TODAY, November, page 45). I am glad to see that there has been some reaction among other scientists to my rather speculative remarks.

I was particularly happy to hear that such a distinguished medical researcher as Peter Gouras (February, page 13) agrees with the reasoning I have described, and thinks that the problem of storage at low temperature may be solved within our lifetime. I hope that he is right.

Ephraim Fischbach (January, page 10) mentions the interesting work of N. H. Grant, who finds that certain enzymatic reactions go faster at around −20°C than at higher temperatures. It would of course be of great interest to know whether such a phenomenon persists down to the low temperatures (around −190°C) envisaged for long-term storage, at which the Arrhenius equation predicts a tremendous decrease in the reaction rate. The experiments already carried out on freezing and storage of individual cells seem to agree with such a decrease.

Finally, there is the letter of Arthur E. Sowers (February, page 14) who takes me to task for "irresponsibly suggesting" that freezing, storing and reviving humans would have widespread applications. I am not sure that I understand the point of Sowers's remarks. If he is suggesting that I am advocating an idea without considering the consequences, I must demur. I am well aware that the technical fea-