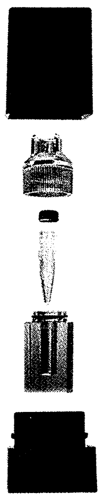

among those. The issues raised in this letter are indeed important ones, and they were addressed at the meeting.

Untapped Source of Diplomats

In her speech at the American Association for the Advancement of Science annual meeting in February (AAAS is the publisher of *Science*), Secretary of State Madeleine Albright indicated her interest in facilitating a scientifically literate State Department (News Focus, "Science gains at State Department," by David Malakoff, 3 Mar., p. 1583). But the first step she mentioned—hiring an upper-echelon official at the State Department to handle scientific matters—is likely to serve no other purpose than to increase the conspicuous top-heavy elitism at the department. The way to improve the scientific literacy of State Department officials, from diplomats to bureaucrats, is to hire more (not less or even none at all) scientists as foreign service officers and science attachés at U.S. embassies overseas.

There is a relatively large pool of trained scientists who have extensive and sophisticated international affairs and global science policy experience who are either ignored or are not considered "diplomatic" material on the basis of their inability to pass an outdated foreign service officer examination. It is perverse that such scientists, who may have lived overseas for many years and may speak a multitude of foreign languages, cannot find positions at the State Department—an agency in which the scientist might find himself or herself, ironically, highly overqualified.

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Respect for the Opposition

Although I agree with the theme of Senator Christopher Bond's Editorial "Politics, misinformation, and biotechnology" (*Science*'s Compass, 18 Feb., p. 1201), I feel that when communicating science issues to the public, one has to consider both language and tone. While reading Bond's Editorial, I often took issue with how he phrased his argument. If I hadn't already agreed with his main point, I might have dismissed his thesis entirely. For example, his sentence "Opposition...has been driven variously by trade-protectionist and anticorporate sentiment, by competing food marketers such as the whole-foods industry, and by scientifically unsubstantiated fears of change and technology" seems to belittle those on the other side of the argument and to characterize their concerns as being irrational. If opposing opinions and concerns in such a debate are not respected, it makes it difficult to reach compromises, let alone convince opponents why some biotechnology advances might be beneficial. Another sentence, "The hysteria and unworkable propositions advanced by those who can afford to take their next meal for granted have little currency among those who are hungry," seems to play to people's emotions rather than their good senses. Statements like this can damage our argument, which is supposed to be based on rationale.

In the age of biotechnology, we should learn how to convince the public that our theories are sound as thoroughly as we would hope to convince a reviewer. The key to successfully implementing scientific advances in the public realm is through education and discussion with the public, not an elitist approach, which could ultimately lead to a public distrust of scientists (and politicians).

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In his Editorial, it seems specious for Senator Bond to suggest that "naysayers" may subvert biotechnology and condemn children of the world to malnutrition, sickness, and environmental degradation. In spite of the gains cited, hunger has not been eradicated anywhere, including in the United States. The solution to the problem of hunger more likely lies in the political realities of today than in the technological fixes of tomorrow. In addition, the prime motivation for much of biotechnology is profit; because most of the areas of the world where hunger is rampant are short on capital, it is hard to see how people in these areas will benefit from the new biotechnologies. And a final point: "naysayers" are not Luddites; they do ask, however, that the risks associated with these new technologies be borne by those who stand to profit from them, and that the biosphere not be used as an experimental resource without the explicit informed consent of those who live within.

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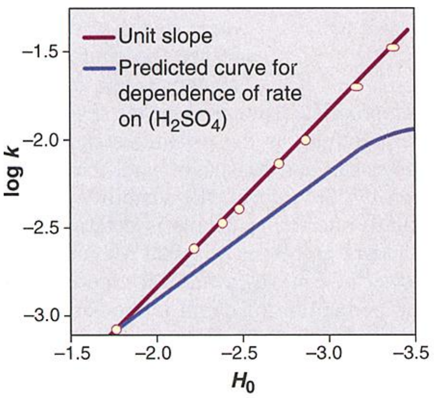
pH Values Below Zero

In the Editor's Choice selection titled "The natural lowdown on pH" (R. Brooks Hanson, 11 Feb., p. 933), the comment is made that "[s]olutions with negative pH are possible theoretically but beyond the range of most sensors and buffers." Ah, yes—but lest we forget, there was a time when the reactions that occur at negative pH values were one of the most studied fields in chemistry. Lewis Hammett published his influential book *Physical Organic Chemistry* in 1940, which popularized the use of physical techniques for the study of organic reaction mechanisms, creating legions of physical-organic chemists in the decades that followed.

One tool introduced in Hammett's book was his "acidity function," now called Hammett H_0. H_0 values, determined with overlapping indicator dyes, can measure acidities up to negative "pH" values of about –10 (which, with assumptions, is equivalent to an activity of hydrogen ions of about 10^{10} molar). I spent 3 years in the basement of the Old Chem building at the University of California at Berkeley in the 1950s, under Don Noyce, studying the kinetics and mechanisms of acid-catalyzed reactions using sulfuric in acetic acid solutions: 1 molar sulfuric acid in dry acetic acid has an H_0 of about –3 (that is, about 3 pH units more acidic than pH 0).

The figure [from (*1*)] shows a plot of



the rate constant for the acid catalyzed reaction of acetophenone with benzaldehyde to make benzalacetophenone (chalcone):

$$\text{Ph-CO-CH}_3 + \text{Ph-CHO} \xrightarrow{H^+} \text{Ph-CO-CH=CH-Ph} + H_2O$$

(Ph represents phenyl, C_6H_5.) The rate constant, *k*, is proportional to the acidity function, H_0, up to an H_0 of –3. Note that *k* does not parallel the concentration of sulfuric acid (H_2SO_4), but rather follows the H_0 function, indicating that H_0 measures acidity and not merely the molarity of added acid.

Studies using H_0 have disappeared from the literature, I now study free radical reactions in biology, Don Noyce has retired, and the only trace of the Old Chem building left on the Berkeley campus is its famous cupola, which now sits atop the Giauque Low Temperature Lab. In the 1970s, however, George Olah developed even more acidic solutions, using "superacids," and was awarded a Nobel Prize. Superacids are made from $FSO_3H\text{-}SbF_5$ mixtures, and extraordinary acidities (equivalent to a "pH" of around –40) are developed that are sufficient to even allow alkanes to ionize:

$$\text{R-H} + H^+ \longrightarrow R^+ + H_2$$

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1. D. S. Noyce and W. A. Pryor, *J. Am. Chem. Soc.* **77**, 1397 (1955).

Close Encounters: Details Veto Depth from Shadows

In his Perspective "Close encounters—an artist shows that size affects shape" (*Science*'s Compass, 6 Aug. 1999, p. 844), Denis G. Pelli explores a striking visual effect seen in portraits by the painter Chuck Close. The portraits are composed of many blocks or "marks" of roughly equal size, each with varying colors and details (such as ellipses or arcs) that differ from those of its neighbors. From a distance the face and its shading appear three-dimensional, but from nearby it becomes a flattened jumble of colors. Pelli notes that the depth in the face is lost when the marks are about 0.3 degree of visual angle or larger. Pelli then presents a mystery: Something prevents us from seeing the depth in the face when we are too close, and that something has to do with the marks, but it is not the marks themselves. They are still visible at the critical distance where the face and its three-dimensional depth become apparent.

We outline below a resolution to the mystery. The effect is triggered by the optics of the eye: Depth is perceived in the face when particular interfering features are not visible to the observer. However, the culprits are not the marks themselves but the small details (loops and contours) within the marks including the gaps between the details. These small details, when visible, block the perception of depth indicated by the shading in the paintings, and the nose falls flat. The marks are visible at the critical 0.3 degree size, but the smaller, offending details cannot be resolved (as we verify below). At that point, the details no longer interfere, the dark regions are seen as shadows, and the nose emerges in depth. What is most remarkable is the power of these small details to shape the interpretation of very large areas of the image.

How do the small details of Close's marks interfere with the recovery of shape from shadow? Shadows often fall on textured surfaces, so the presence of some mottled texture (the visible marks) within the shaded region does not rule out a dark area as a shadow. However, a shadow must be darker than its surround and have an appropriate border (*1*–*3*). Where a surface