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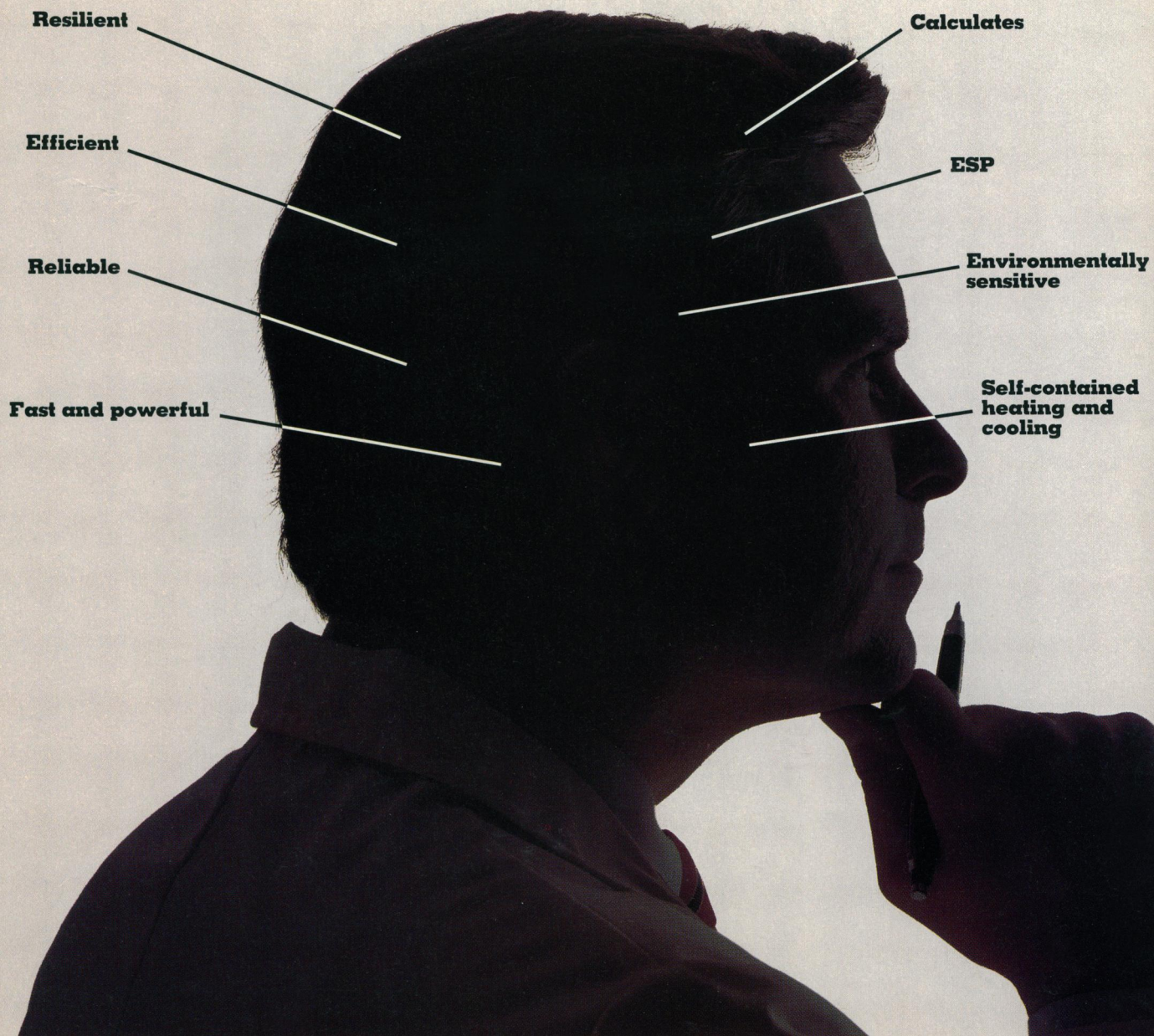
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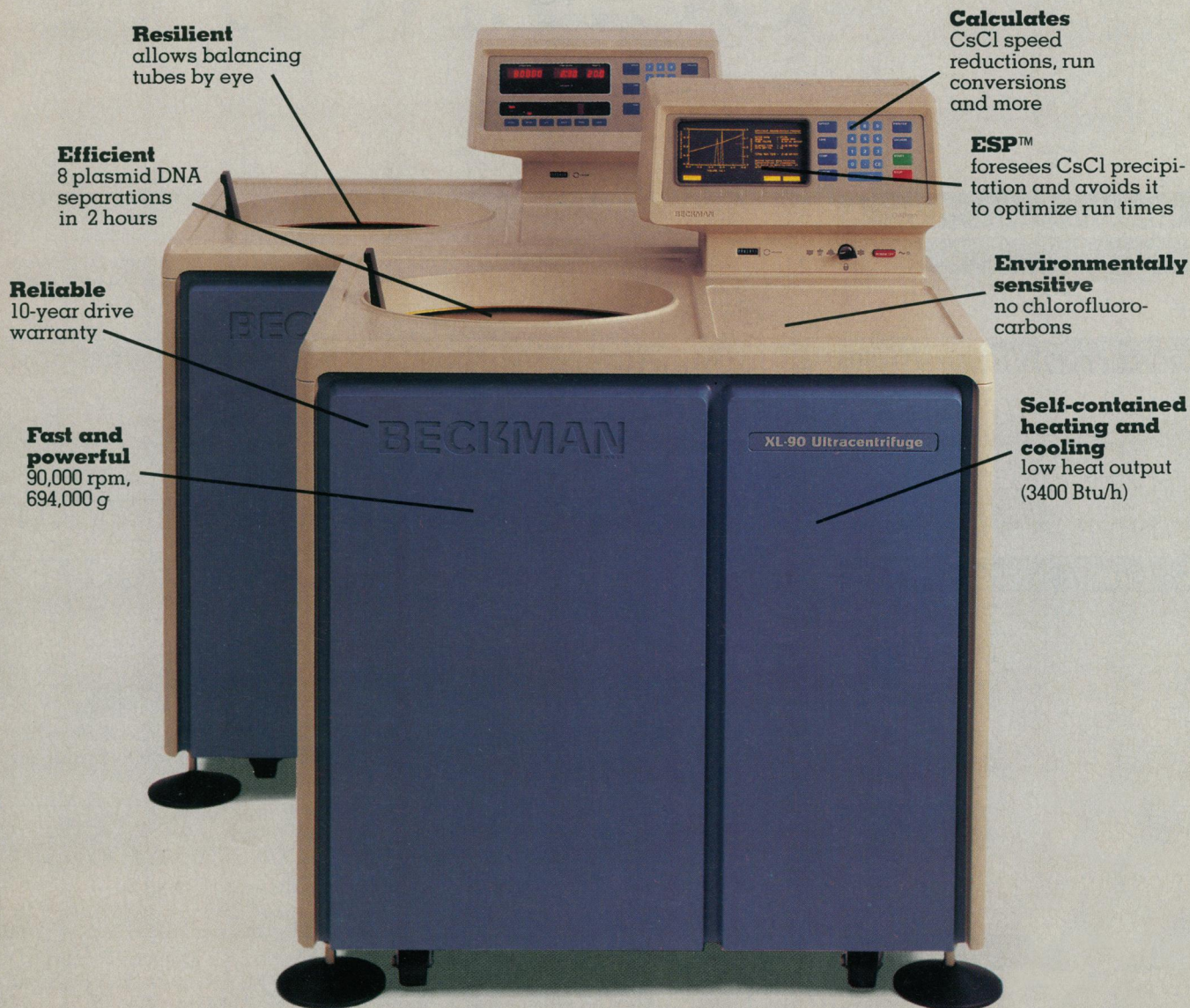
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COVER Lightning over a Colorado night sky. Recent attempts to understand such electrical discharges are motivated by spectacular accidents involving aircraft and spacecraft. Uman and Krider (page 457) describe research on natural and artificially initiated discharges that aims to both clarify the physics of lightning and find new ways of protecting against lightning damage. [Photo by John Deeks, Science Source/Photo Researchers]

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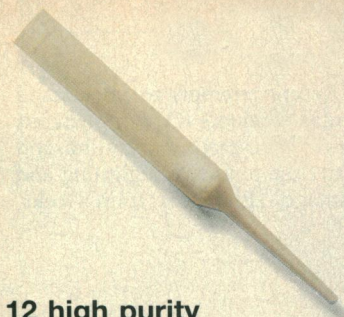
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This Week in SCIENCE

Lightning

IN 1987, launch of an unmanned Atlas-Centaur rocket triggered a flash of lightning that broke up the vehicle; in 1969, the Apollo 12 spacecraft initiated a lightning strike that caused major damage to the system, although it did not injure the crew or destroy the craft; in 1963, a Boeing 707 exploded after being struck by lightning, and all passengers and crew were killed. These are some of the very dramatic events that have stimulated recent research into the causes and characteristics of lightning (cover). Most lightning is produced naturally, but man-made structures (TV towers) and human activities (flying) are able to initiate "artificial" lightning flashes. Uman and Krider discuss what has been learned about these two types of lightning (page 457); the information supports a two-pronged approach to dealing with lightning that includes both mapping and avoiding lightning and hardening susceptible systems against lightning's effects. For certain lightning-induced accidents—such as those accidents that involve aircraft, which are now understood as generally the results of triggered rather than intercepted natural lightning—a combined approach should lead to a reduction in lightning-associated damage.

Chinese climate record

ICE cores from China's Qinghai-Tibetan Plateau provide a climate record that extends back into the last glacial stage and perhaps back more than 100,000 years (page 474). This is a region of the world that is thought to have an important influence on global climate patterns as well as on regional monsoons but from which little other climatologic information is available. Thompson *et al.* drilled down to bedrock through the Dundee ice cap, a 140-meter-thick glacier that rises 5325 meters above sea level. The long and detailed climate record, the result of a cooperative effort between the United States and China, was inferred from the

dust content and chemistry of the ice layers. A major change apparently occurred in the climate some 10,000 years ago near the end of the last glacial stage; it caused the region to become warmer and drier and less dusty. At this transition, the changed climate apparently reduced the transport of dust onto the plateau: the amount of dust in the cores decreased abruptly over about a 40-year period. Oxygen isotopes indicate that the highest postglacial temperatures were attained 6000 to 8000 years ago and that these high temperatures were matched in the 1940s, the 1950s, and the 1980s. This suggests that the trend toward global warming may be under way in central Asia.

Ancient spinneret

A fossil from a *Konsvat Lagerstätte*—a finely preserved, rich, and diverse fossil deposit—from Middle Devonian rocks in Gilboa, New York, indicates that there were spiders on the earth that could spin silk some 385 million years ago (page 479). This is the earliest certain evidence for spiders that has been recovered so far. The specimen, described by Shear *et al.*, is that of a spinneret, the spider's abdominal silk-spinning appendage. The evolution and the patterns of divergence of spiders have been enigmatic, and morphologic features of the fossil spinneret and of its spigots (from which silk flows from glands) have not established a definitive phylogenetic association of this specimen with a specific group of living or fossil spiders. Spiders are known to spin silk for egg sacs, for drag lines, for trapdoor linings, and for aerial webs. The Devonian spider may have spun aerial webs in order to catch prey or it may have sat and waited to pounce on passing arthropods.

Mapping the pitch processor

THE pitch of a sound is a subjective entity, yet measurements of magnetic fields emanating from

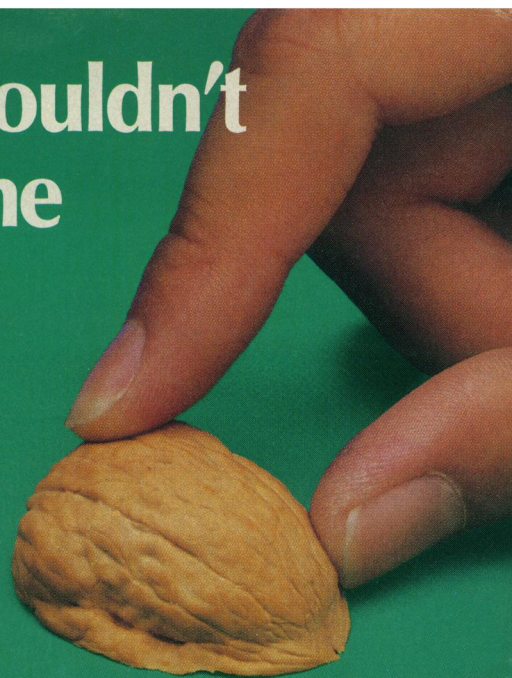
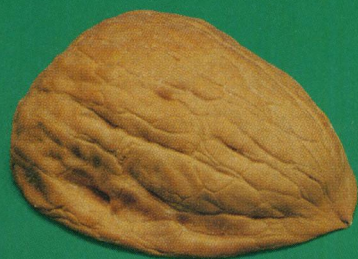
the skull after presentation of a sound stimulus show that pitch has an objective correlate in the brain (page 486). Pantev *et al.* report that the sources of magnetic waves above the auditory cortex reflect pitch (which is the perception of the sound) rather than frequency (which is the physical stimulus that produced the sound). A simple fundamental tone (the "first harmonic" of a harmonic series) and a complex tone (consisting of higher harmonics in the same series or its "overtones") induced magnetic waves at the same brain locations. This explains why the "missing fundamental" can be perceived in a sound mixture that contains only the higher harmonics. The sound processor in the auditory cortex therefore differs from the processor in the cochlea of the ear in which the response is to frequency and not to pitch.

Whooping cough vaccine candidate

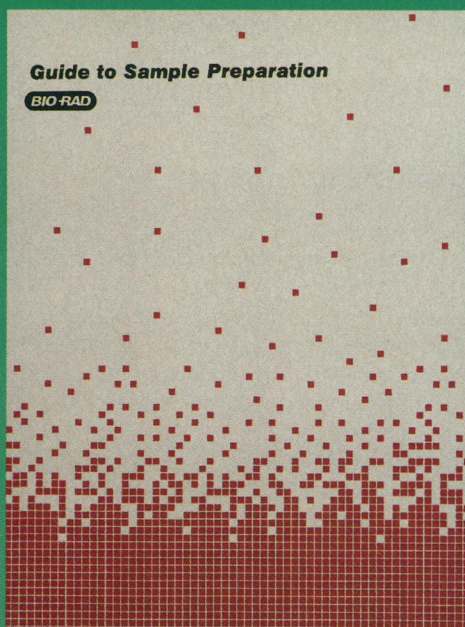
IT is estimated that 1 million children around the world die each year of whooping cough, a respiratory disease that is caused by *Bordetella pertussis*. The disease can be prevented by the three-component DPT (diphtheria, pertussis, and tetanus) vaccine, but, because the whooping cough-specific component of this vaccine (the "P" component) causes an unacceptably high number of neurologic complications, there are many areas of the world in which the vaccine is not in use. Efforts have continued in a number of laboratories to alter or to find some form of the pertussis toxin that will elicit a protective immune reaction in a host but will not be toxic to the host's nervous system. A promising candidate with these characteristics is described by Pizza *et al.* (page 497). Genetic engineering techniques were used to make a slight alteration in a crucial subunit of the pertussis toxin; the subunit became chemically nontoxic for the host animal but remained immunogenic and was effective in protecting mice from a lethal dose of whooping cough bacteria.

■ RUTH LEVY GUYER

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Technology and Environment

Engineers face the unenviable necessity of attempting to reconcile the demands of two quite different worlds, one governed by the laws of nature and the other by the laws of lawyers. To some extent, engineers have always found it desirable to factor public attitudes into their designs, but the major considerations earlier were such eternal verities as the second law of thermodynamics. Now, however, a predominant boundary condition is a frenetically changing public opinion. A design for a long-lasting facility that makes sense today can be rendered obsolete tomorrow. What can the engineering profession do to enable its members to cope with this phenomenon? How can universities prepare their students to function in such circumstances? The answers to such questions must necessarily be fuzzy. A report issued by the National Academy of Engineering is an effort to begin to address the matter.* As noted in the report, many people feel that economic, technological, and scientific developments are accompanied by ever-larger risks for environment, society, and health. The authors neither press the panic button nor conclude that this is the best of all possible worlds. However, we are reminded that it was technology that forestalled the original Malthusian vision of population outrunning subsistence and furthermore, that many environmental problems have not proven as serious as originally forecast. Mercury in swordfish and pesticides in cranberry bogs are two examples.

The media and the public have tended to view industry as a collection of pollution sources. At one time this was true, but current attitudes do not reflect progress that has been made by many companies in emissions control and waste management through redesign and recycling. The focus on industry tends to blind us to the role of individuals and their behavior. Some of the toughest issues facing us—urban air pollution, destruction of rain forests, and loss of habitat—are the result of large-scale cultural patterns, the summed effects of millions of people making individual decisions.

One of the major problems that must be dealt with fairly soon is waste management. Disposal sites are filling, and no one wants a new one located nearby. The report asks, "Can society afford to function in a 'throwaway' mode for products such as diapers, batteries, paper, and beverage containers?"

The greenhouse effect is a matter that will continue to trigger alarms when the weather is hot or dry and to be of limited concern in winter. A substantial persistent global elevation in temperature is unlikely to occur in this century. But we should develop means of limiting possible deleterious effects in the more distant future. Ultimately, a drastic decrease in global emissions of CO₂ might be sought that would require major changes in our energy system. It might be desirable to expand use of nuclear energy. The public will have to find a balance between environmental concerns and standard of living.

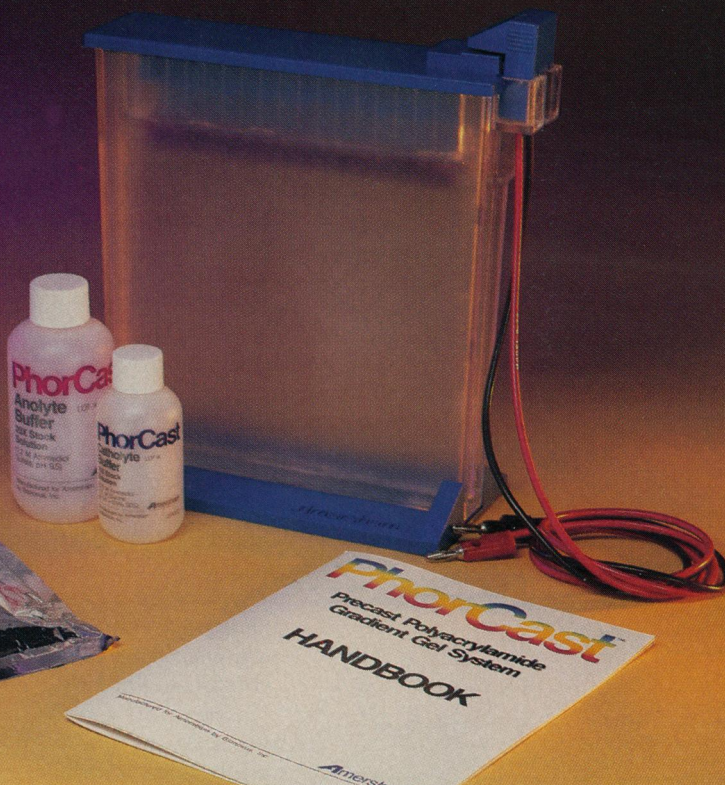
An example of the impact of laws on engineering designs comes from the electrical utility industry. Before 1965 there was little legislation affecting power plants. In the period from 1900 to 1965 thermodynamic efficiency of power plants increased from 8% to 42%. Cost of kilowatt capacity in terms of constant dollars dropped by a factor of 4. Since 1965 a patchwork of some 33 laws has been enacted. As a result, thermodynamic efficiency has decreased, and capital costs in constant dollars have climbed by a factor of 4.

When the lawyers legislate on technical matters the product is often ridiculous. An example cited in the report involves treatment of domestic wastes. When the effluent is to be discharged into a eutrophic waterway a super treatment is mandated. However, storm ditches which spew out filth to the waterway are left unregulated.

In the report, Victoria J. Tschinkel points out that in the past 20 years the legal system has produced an adversarial, combative climate in which it is virtually impossible for people from industry to discuss facts with colleagues in government or with the public. She further states that many knowledgeable people are constantly in litigation and constrained from using each other's talents cooperatively. She concludes that the legalistic approach has produced a staggering load of regulations. It has created a legalistic process-oriented rather than a results-oriented approach in a sector where the result, namely environmental quality, is what we seek and need.—PHILIP H. ABELSON

*J. H. Ausubel and H. E. Sladovich, Eds., *Technology and Environment* (National Academy Press, Washington, DC, 1989).

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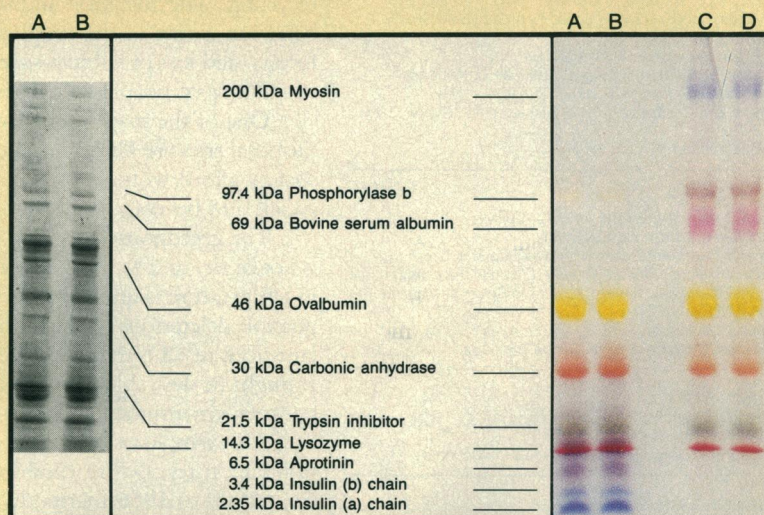
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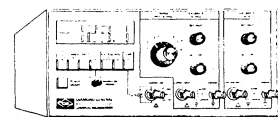
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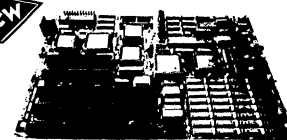


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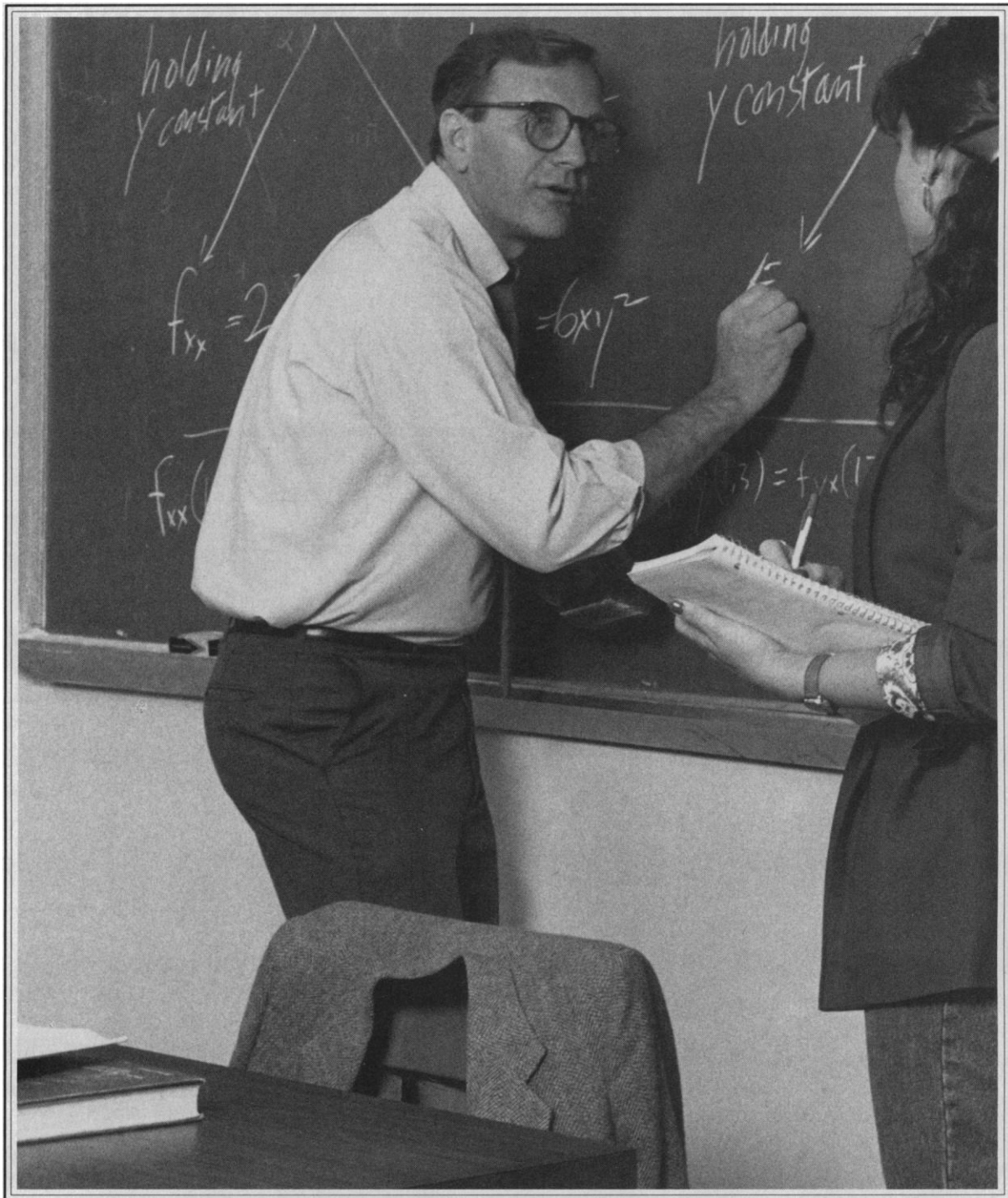
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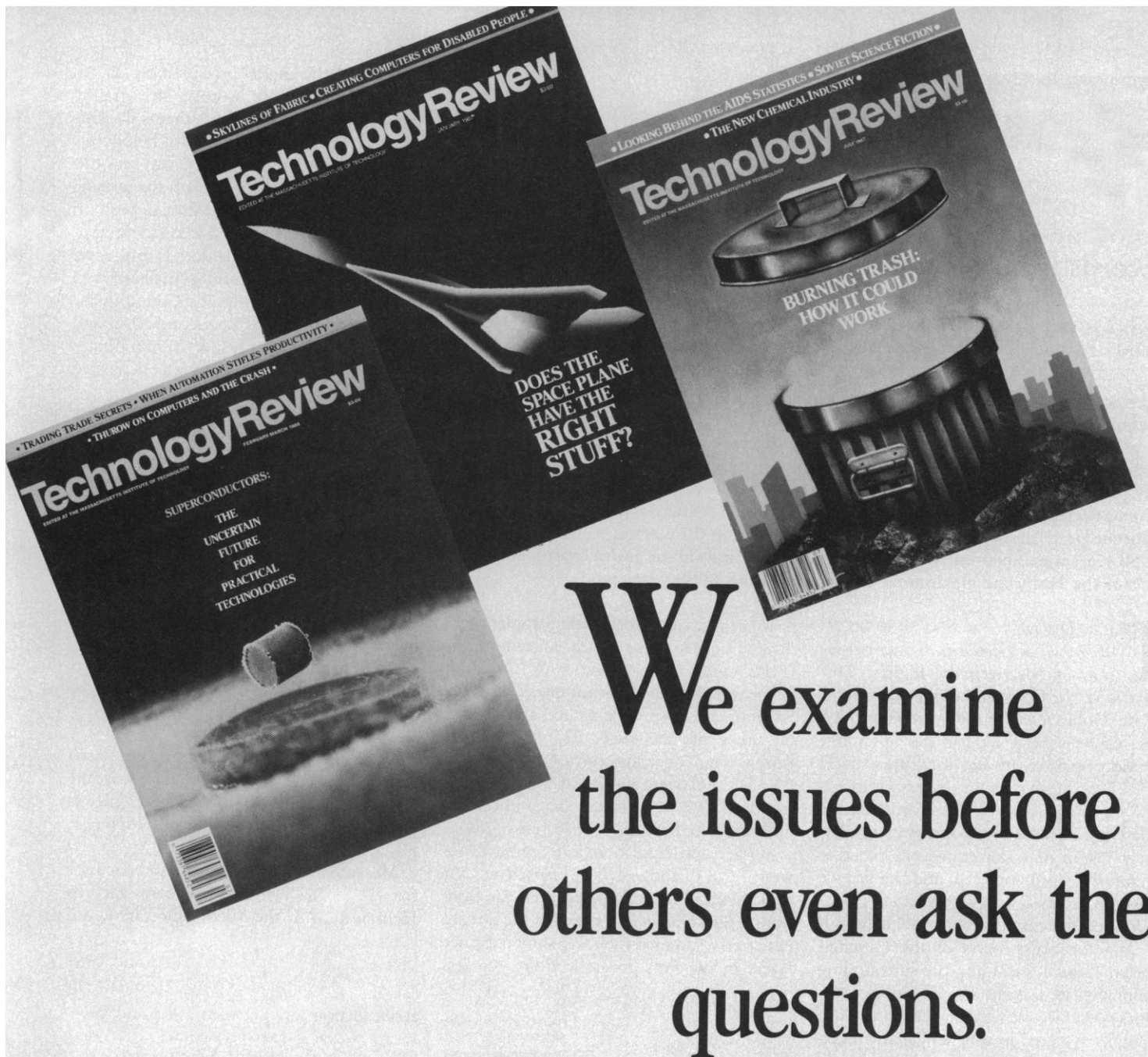
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