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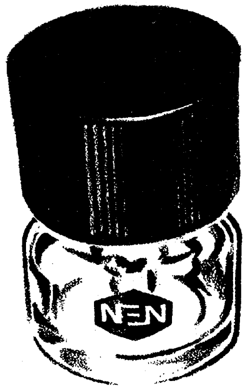

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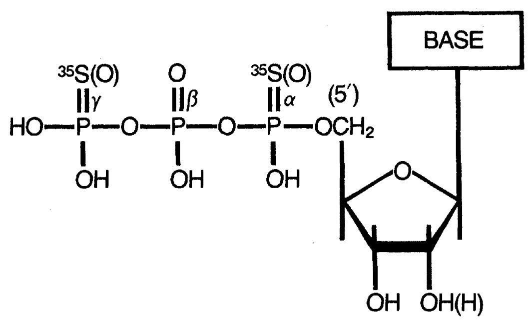

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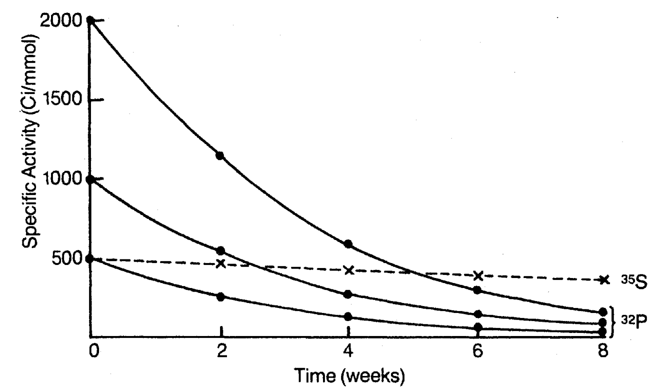

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COVER

Devil's paintbrush or orange hawkweed (*Hieracium aurantiacum* L.). Originally from alpine and northern Europe, this ornamental composite was imported for gardens. It has invaded meadows and pastures in northeastern North America and northern Japan, where it spreads by wind-borne seeds and runners. The ecology and natural enemies of this weed are being investigated. The syrphid fly shown here benefits from floral nectar, but the apomictic flowers do not require pollination to set seeds. See page 134. [S. W. T. Batra, U.S. Department of Agriculture, Beltsville, Maryland 20705]


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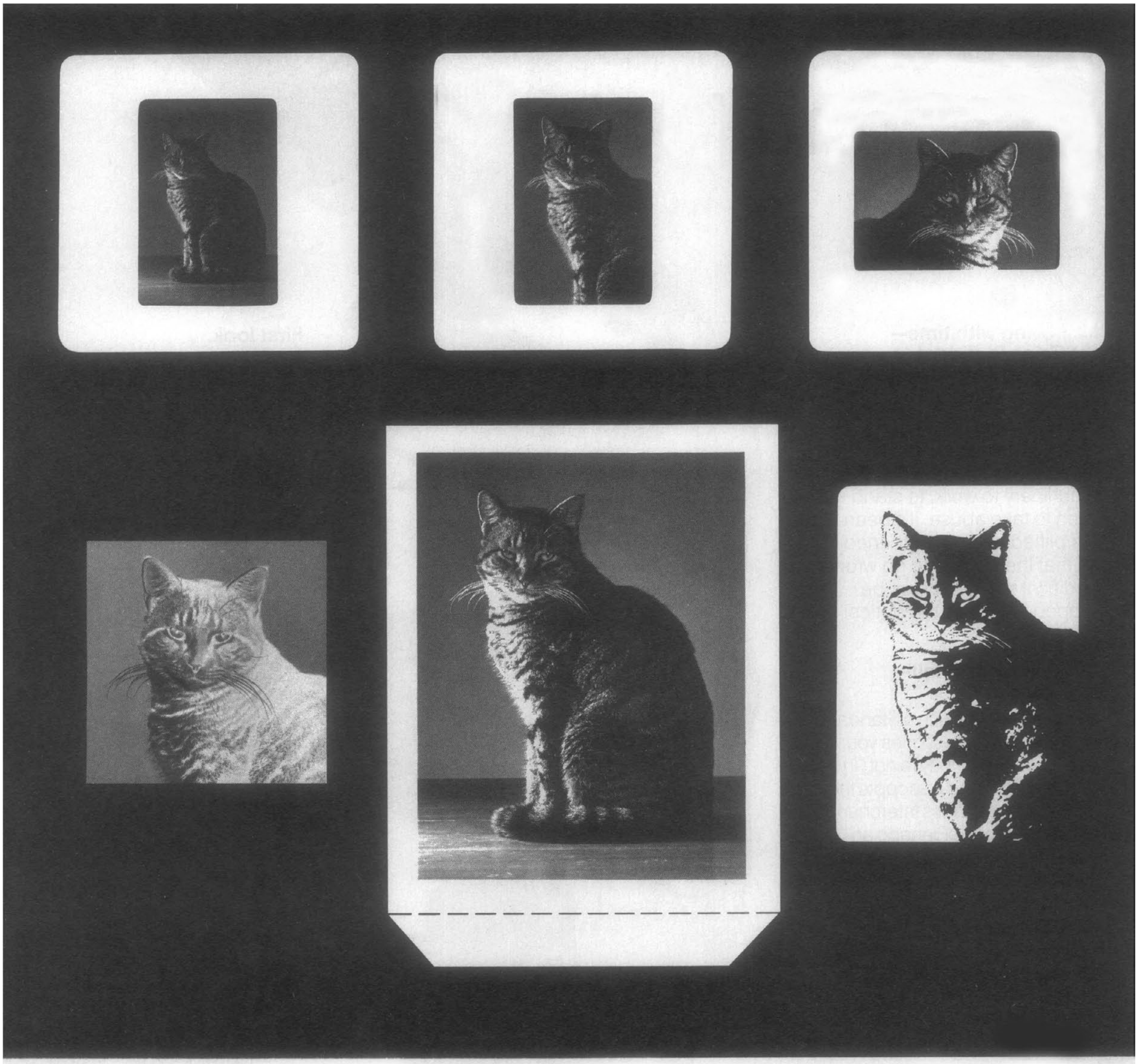

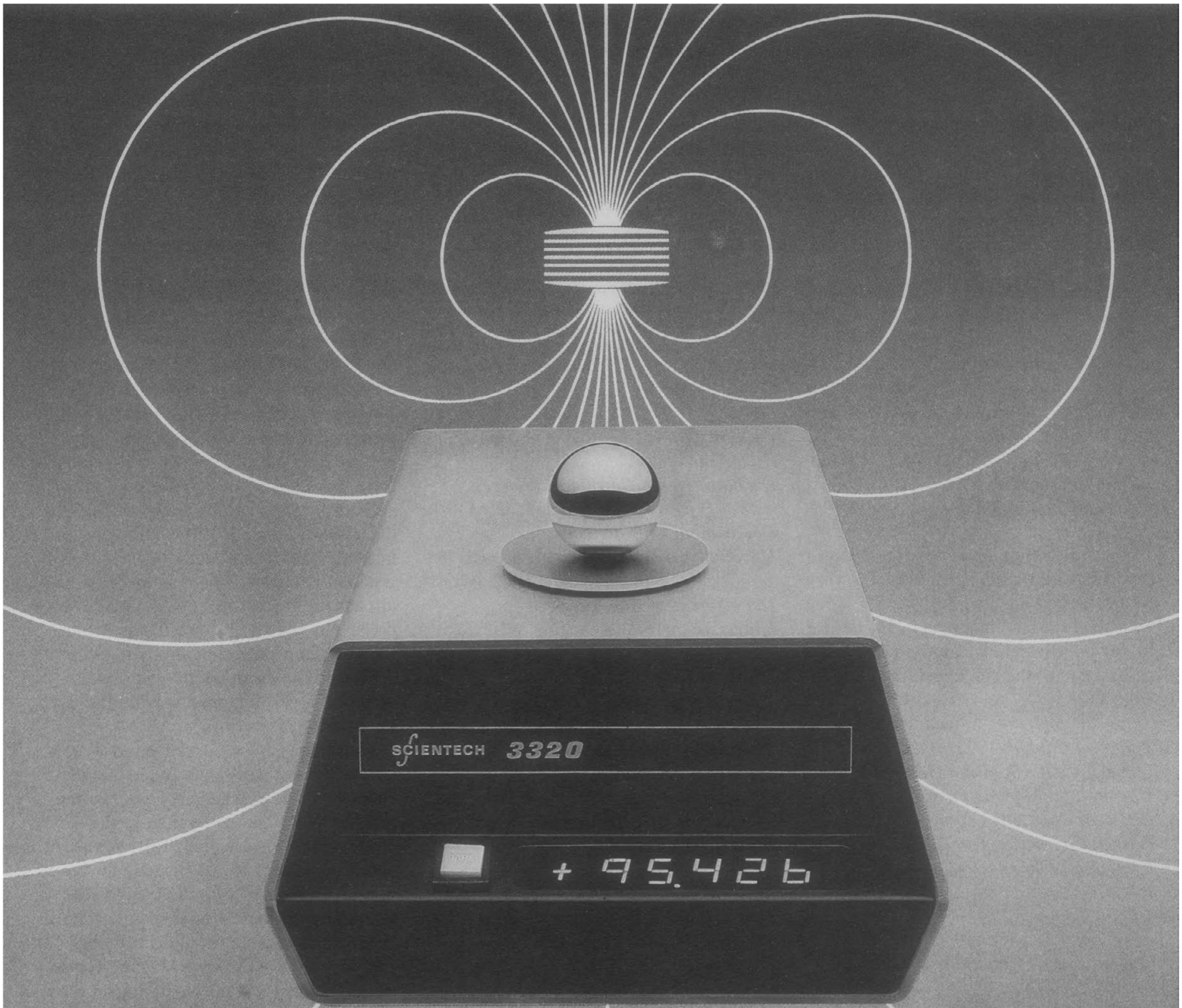
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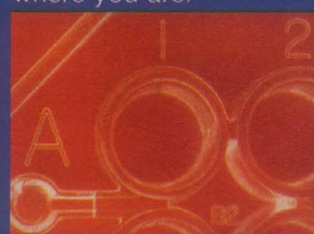

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SCIENCE

Creationism and the Age of the Earth

For most of the 20th century religion and science in this country have coexisted with relatively little controversy. Scientists did not accept literally the version of beginnings set forth in Genesis, but many were touched with awe when they regarded the order and complexity of nature. They respected the ethical values fostered by organized religion. Some scientists were agnostics but few were atheists. This peaceable relationship has been strained by the people who allege that there is a body of knowledge which they call creation "science" that merits equal treatment with the teaching of evolution in primary and secondary schools.

The creationists also state that the age of the earth is between 6,000 and 10,000 years. In taking this stance they are in conflict with data from astronomy, astrophysics, nuclear physics, geology, geochemistry, and geophysics. In these disciplines an enormous mass of observational and experimental data has been accumulated bearing on the age of the earth and of the universe. Many independent approaches whose results buttress each other are in agreement that the age of the earth is much greater than 10,000 years. Substantial evidence indicates that the age of the solar system is about 4.5 billion years.

In the dating of ancient materials the best values are obtained by radiometric methods. At least five independent radioisotope clocks have been employed. Perhaps the best of these is one that depends on decay of ^{238}U and ^{235}U to the end products ^{206}Pb and ^{207}Pb. By use of this method the ages of rocks 2600 million years old have been determined with a probable error as small as 1 million years. When granitic magma solidifies, zircon crystals ($ZrSiO_4$) are often formed. The atomic radii of uranium and zirconium are nearly equal, and uranium is usually present in the zircon crystal as a proxy for zirconium in the structure. The radiometric clock starts when the crystal forms. With the passage of time ^{238}U decays to ^{206}Pb and ^{235}U decays to ^{207}Pb. Under favorable conditions both isotopes remain locked in the crystal. Laboratory processing isolates the lead for mass spectrometric determination. In many thousands of instances rocks have been dated by three or more independent clocks and the ages determined have been in good agreement.

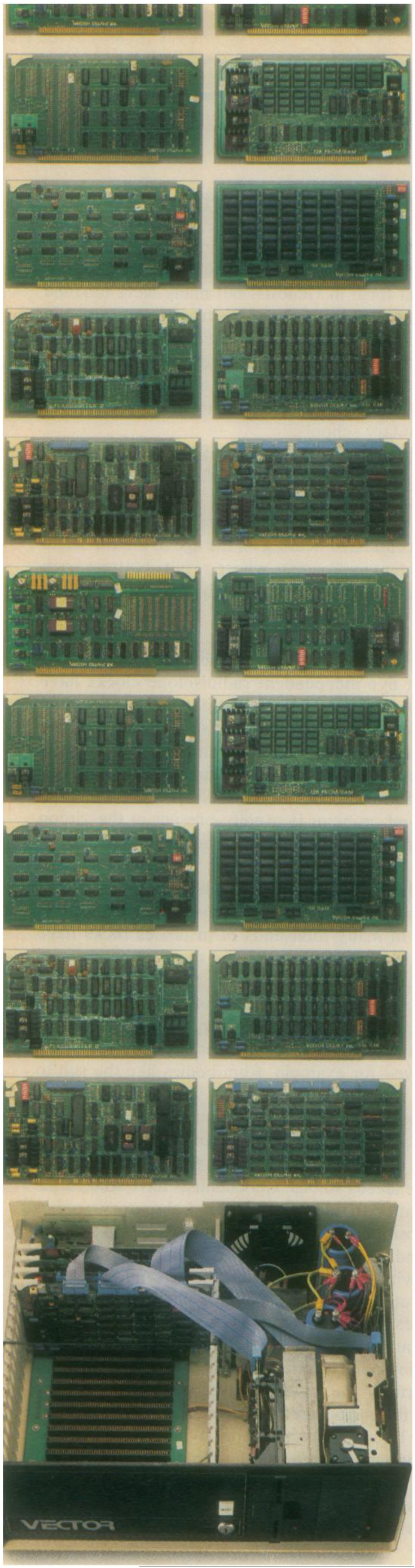
Astronomy and astrophysics have provided a set of distance and time scales that lead to an age for the universe of 10 billion to 20 billion years. This great age is consistent with the times which nuclear physicists calculate are required for stars to evolve—for example, from bodies like the sun to white dwarfs.

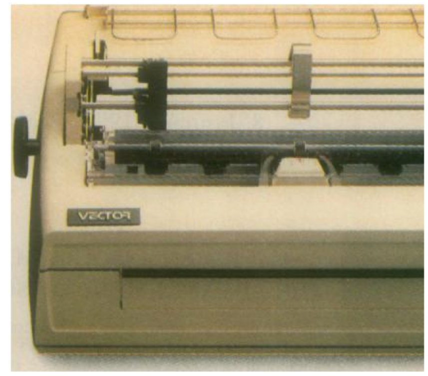
Data from geology, geochemistry, and geophysics all testify that the age of the earth is much greater than 10,000 years. For example, geologists have encountered a large number of formations in which the total number of annually deposited layers far exceeds 10,000. Geochemists have studied the decomposition of organic matter to form petroleum. Laboratory studies show that the rate of decomposition is such as to require millions of years to release the hydrocarbons found. Laboratory studies of amino acids found in fossils are also in accord with ages far greater than 1 million years. Geophysicists note that the rate of motion of tectonic plates is such as to require many millions of years for such events as opening of the Atlantic Ocean and raising of high mountains.

The efforts of the tens of thousands of scientists who have produced data relevant to the age of the earth or the universe have been motivated by a search for truth. If the age of the earth were 10,000 years or less, that result would have been proclaimed by many and accepted by all.

In contrast, those who propound creationism have started with a literal interpretation of the Bible. They have no substantial body of experimental data to back their prejudices. Truth is not on their side. In the end their activities must bring only harm to their cause.—PHILIP H. ABELSON

For further reading on creationism see *Science*, 6 November 1981, p. 635; 4 December, p. 1101; 11 December, p. 1224; and 1 January 1982, p. 33; and *Science 81*, December, p. 53.





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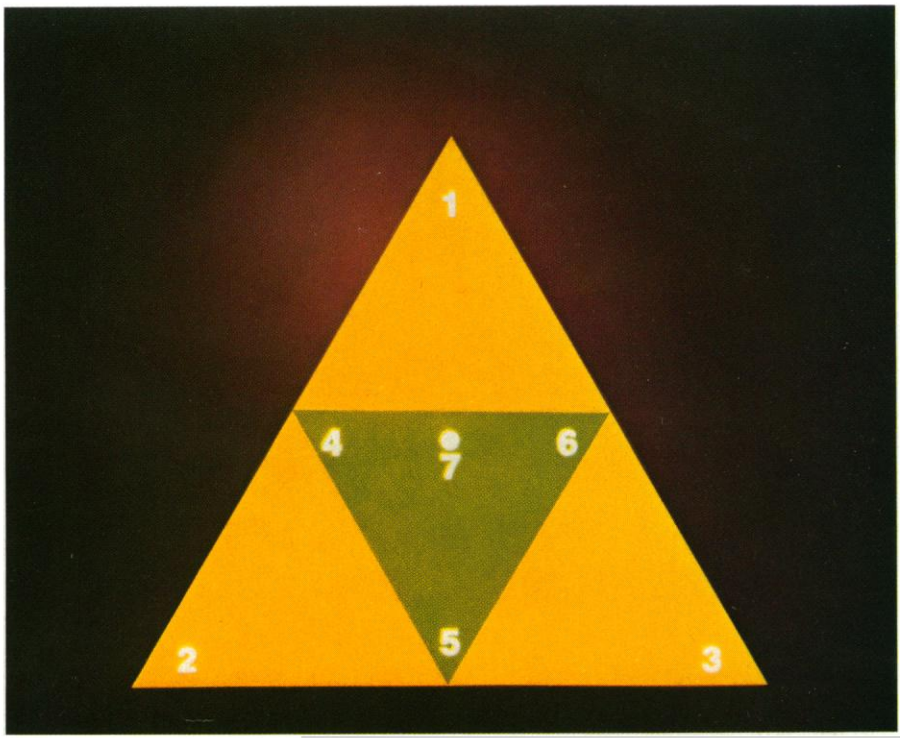

The 4-solvent, 7-step technique can be defined by a triangle. The numbers represent the seven steps, each of which uses varying compositions of two of the solvents. When the seventh step is completed, the separation is done. Solvents are selected with widely differing actions and with water or hexane as a carrier.

Du Pont's new 4-solvent, 7-step technique signals a new, more efficient era in liquid chromatography. Not only will your productivity be increased, but results will be more precise, and you will have complete assurance that your experiments are minimized in number. No more gnawing feelings of "just one more run" to get a better separation.

The 4-solvent, 7-step technique is a simple approach to HPLC separations—not a complicated one. Developed in Du Pont laboratories by J. J. Kirkland and co-workers, the technique is a proven procedure for methods development routines. By completing the solvent optimization routine with 4 solvents, you arrive at the best possible separation of a mixture. And Du Pont has developed a graphics display module that lets you follow visually and control every step of the seven experiments required by the technique.

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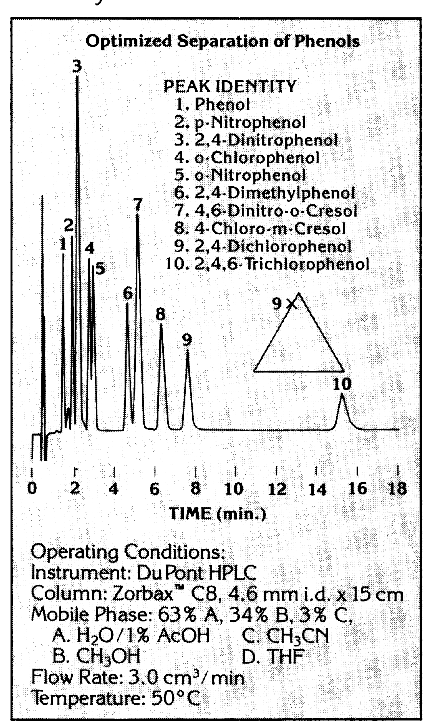

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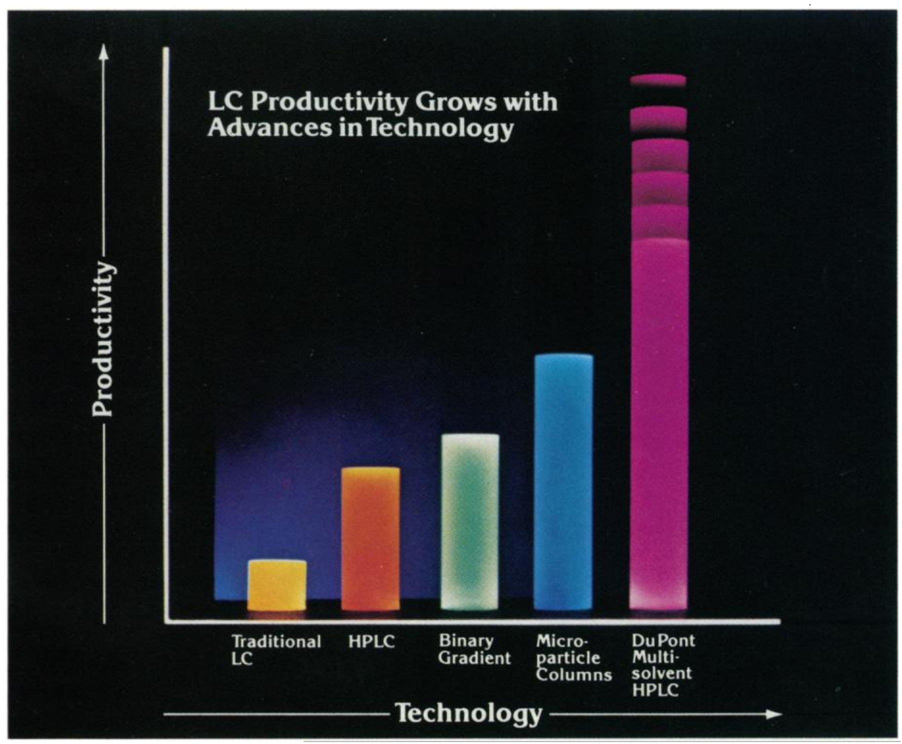

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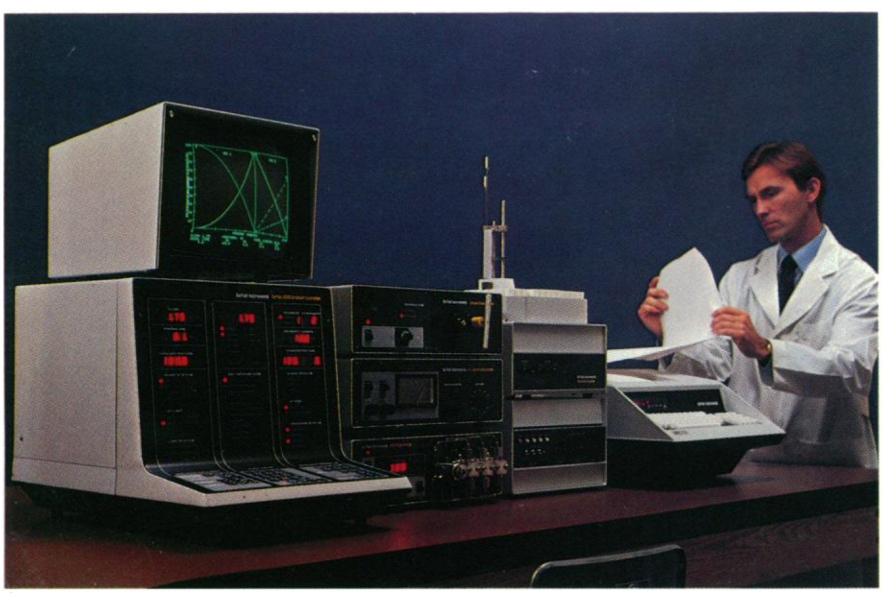

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Please turn the page for a brief look at 4-solvent, 7-step theory.

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A Brief Look at 4-solvent Theory

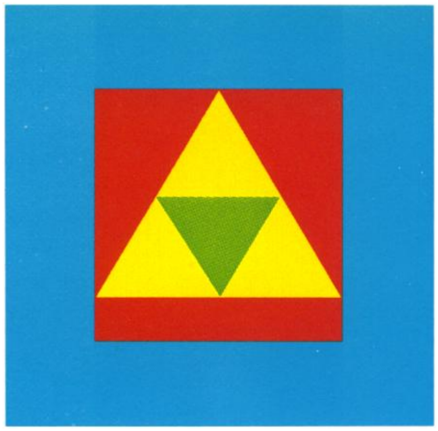
The quality of an HPLC separation is judged by its resolution. Until now, all advances in chromotographic technique have mainly involved column efficiency, retention or capacity. Developing a model or rationale for optimum selection of the mobile phase had not been possible.

This is precisely what J.J. Kirkland and J.L. Glajch have achieved with the 4-solvent, 7-step technique developed in the DuPont laboratories. Their first step was to use the Snyder selectivity triangle[1].

In this triangle, the most common HPLC solvents have been divided into eight major groups, each of which has different selectivity in a separation. Solvent groups are placed within the triangle on the basis of their relative strength as proton acceptors, proton donors, or dipole interaction. Those groups closest to the vertices of the triangle are strongest in these factors. (Fig. 1).

In making a choice of three solvents for optimizing selectivity, solvents are chosen from groups nearest to the three vertices of the triangle, so as to produce the largest differences in solvent action. Finally, the weak or strength-adjusting solvent—water or hexane—is chosen. Therefore, four solvents are required to carry out the optimization routine.

In developing the 4-solvent technique, Kirkland and Glajch[2] use a triangle to define the entire selectivity space of a separation, Fig. 2. This triangle may be plotted within the confines of seven



definitive isocratic experiments using combinations of the four solvents selected.

The first of these experiments uses two of the four solvents (methanol-water, for example) which defines one vertex of the optimization triangle. The remaining two vertices are defined by two additional experiments, again using each of the other two solvents, plus water or hexane,

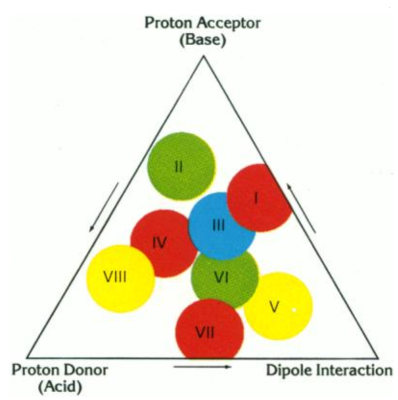


Fig. 1. The Snyder selectivity triangle divides the most common HPLC solvents into eight groups. Position of the groups within the triangle depends on their relative strength as proton acceptors, proton donors, or dipole interaction.

depending on the mode of the experiment. Solvent compositions for the final four experiments are fixed; the blend ratios are defined on the optimization triangle sides and center, Fig. 2.

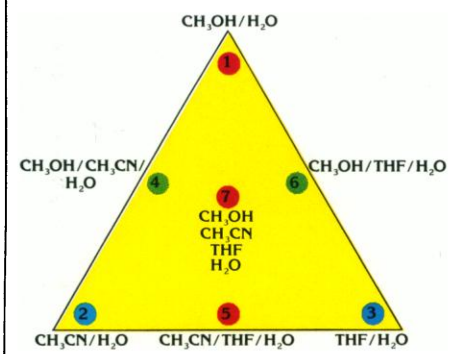


Fig. 2. The 7-steps and defined concentrations of the solvents used for each step are shown in this triangle.

Following these seven chromatographic runs, an optimum solvent region may be defined from visual examination of the chromatograms. Additional refinements may be made for the separation and require one or two additional runs.

Detailed theory and explanation of the optimization technique will be found in references below.

References
1. L.R. Snyder; J.Chrom. Sci., *16* (1978), 223 ff.
2. J.L. Glajch, J.J. Kirkland, K.M. Squire, J.M. Minor; J. Chromatography *199* (1980), 57 ff.

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