for physical union in compounding: A compound word is a union of two or more words which are joined together either with or without a hyphen. (For example: *light-year*; *radiotelegraphy.*)

Proper emphasis is placed upon the *two* problems always involved in compounding, which should not be but often are confused: (1) Is compounding (the physical union of words) necessary in any particular instance? (2) If so, should the compound word be hyphened or solid?

The first of these problems is answered under the headings "Words Preferably Not Compounded" and "Words Properly Compounded"; the second, under the headings "Hyphened Compounds" and "Solid Compounds."

The general principle governing compounding (the physical union of words) comprehends only the avoidance of ambiguity, whether that ambiguity is or is not due to syntactic incongruity.

The general principle governing the use of the hyphen in compounding comprehends both visual intelligibility and ephemeral usage.

There are only four main rules elaborating these general principles, each of which is followed by subrules setting forth specific categories of words to which it is applicable; moreover, all the rules harmonize completely with one another as well as with the general principles.

The first two main rules relate solely to compounding (the physical union of words) and may be jointly paraphrased as follows: If the meaning of two or more words used in regular order and in unconnected succession would be perfectly clear, compounding is unnecessary; if the meaning would not be perfectly clear, compounding is essential. (For example: *four o'clock,* two words, time; *four-o'clock,* compound word, a plant.)

Note that here there is an arbitrary joint meaning in the compounded words that is entirely lacking in the two-word phrase but that the word order is identical, the syntax being perfectly regular. It is irregular syntax, however, which most frequently makes compounding necessary; it is always irregular syntax that gives rise to the greatest difficulty. Therefore the subrules to the two main rules given above set out clearly the categories of word-sequences that are the most perplexing in compounding. Examples coming under these subrules are *source material, leaning tower, to wit, one half (of)* and *right of way* (separate words); *X-ray, one-half* (adv.), *to-do* (noun), *spinning-wheel* (implement), *know-it-all* (noun), *copyholder, airship,* and *shipbuilding* (hyphened and solid compounds).

The main rule governing the hyphenation of compound words is as follows: A hyphen is used to aid readability and denote temporary expediency.

All the following subrules indicate particular instances where the hyphen is essential for one of the purposes stated in the main rule. For example: *light-tight, loud-speaker* (radio), *four-o'clock* (plant), *ton-mile-day* and *old-age* (used adjectively) are all hyphened under some specific rule.

The main rule governing the solid form of compounds is very simple: Compounds for which a hyphen is not specifically provided are written as solid words. (For example: *hammerharden.*)

Other specific rules relate to "Prefixes, Suffixes and Combining Forms"; "Derivatives of Compounds," and "Elliptical Compounds." In this connection it should be stated emphatically that prefixes and suffixes form derivatives—not compound words; but since the hyphen is used in exceptional cases with all affixes (for example: *un-ionized,* hyphened to distinguish it from *unionized,* solid), any consideration of the subject of hyphenation would be incomplete unless such exceptional usage had been indicated. With regard to compound words, however, the reverse is true: there are no exceptions whatsoever to any rule for compounding in the entire system; and it is this invariable freedom from exceptions that makes it unique, workable and adaptable to all needs.

Lack of space precludes the giving of further details regarding this system; but sufficient has been said to show that it definitely provides for the non-compounding or compounding of every possible group of words used in juxtaposition. Its general acceptance by all scientific bodies for the compounding of purely scientific and technical words would prove helpful to them in straightening out their complicated problems.

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LEONARDO DA VINCI ON ISOSTASY

MODERN theory of isostasy originated with Dutton, who coined the term and based his theory unassailably on fundamental laws of statics.[1] The earlier elaborations of Pratt and of Airy had been challenged, and these should not be confused with Dutton's more general and less vulnerable presentation.

The recently translated Notebooks of Leonardo da Vinci reveal that the sixteenth century genius had anticipated Dutton vaguely, though Leonardo's insight into isostasy was wedded amazingly to the geocentric theory which later in life he abandoned. He clearly assigns the heights of mountains to their lesser density. To quote his words:

> That part of the surface of any heavy body will become more distant from the center of its gravity which becomes of greater lightness. The earth therefore, the element by which the rivers carry away the slopes of mountains and

[1] *Bull. Phil. Soc. Wash.*, 11: 51–64, 1889.

bear them to the sea, is the place from which such gravity is removed; it will make itself lighter and in consequence will make itself more remote from the center of gravity of the earth, that is from the center of gravity of the universe which is always concentric with the center of gravity of the earth. . . . The summits of the mountains in course of time rise continually.[2]

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I AM preparing a study on the great mathematician, Joseph Louis Lagrange (1736–1813), and would welcome any information concerning MSS (letters from him or to him) in public or private libraries. I would gladly pay for photostatic copies of such MSS and the owner's courtesy would be fully acknowledged.

GEORGE SARTON

QUOTATIONS

INTERNATIONAL COOPERATION IN SCIENCE

ONE occasionally hears the statement that the trend of intellectual leadership is westward across the Atlantic. In proof of the assertion specific fields are mentioned, such as neuro-surgery, astronomy, dentistry and perhaps orthopedics, in which America has won pre-eminent standing. But this argument overlooks the many fields in which leadership, certainly until the war began, was still in Europe and the many others in which genius and stimulation are as potent on one side of the ocean as on the other. In physiology, for example, it would be difficult to determine whether the leadership lies in Europe or in the United States. The same is true of anatomy and pathology. In fields like pharmacology, tropical medicine, ophthalmology, legal medicine, social medicine and dermatology—to mention only a few—leadership is unquestionably still in Europe, or was in 1939. In mathematics, the English are indisputably pre-eminent in analytic number theory; the Russians are making important contributions in topology and probability, the French in algebra. America can not match the group of European scientists in the important fields of enzyme chemistry and the organic chemistry of natural products. Nowhere else in the world can one duplicate or even approach the coordinated and cooperating Scandinavian group which is focusing so many precise techniques of chemistry and physics on problems of biology.

If one is tempted to question the vitality of science in Europe, it is interesting to note that the most dramatic scientific development of the year 1939 originated there, *i.e.*, the splitting of the atom of the heavy element uranium and its transmutation into barium and other light elements. This realization of the old dream of the alchemists was based upon results obtained in 1934 by the Italian physicist Fermi; but the disintegration products of uranium were first directly observed in 1939, by Hahn and Strassmann of Berlin.

[2] The Notebooks of Leonardo da Vinci, Edw. MacCurdy, Vol. 1, p. 344.

America needs to be humble about this question of intellectual leadership. In spite of the anxiety and insecurity abroad during these recent years, of the six Nobel prizes awarded in science in 1939, five went to Europe and one to the United States. In countless ways we are dependent upon Europe for stimulation and leadership in relation to many segments of our intellectual and cultural activity.

If because of war-exhaustion or chaos the universities and laboratories of Europe should be forced to suspend their fundamental activities for even half a decade, the consequences to the intellectual life of America would be immediate and disastrous. For scientific growth is almost invariably the result of cross-fertilization between laboratories and groups in widely separated parts of the world. Only rarely does one man or one group of men recite with clear, loud tones a whole important chapter, or even a whole important paragraph, in the epic of science. Much more often the start comes from some isolated and perhaps timid voice, making an inspired suggestion, raising a stimulating question. This first whisper echoes about the world of science, the reverberation from each laboratory purifying and strengthening the message, until presently the voice of science is decisive and authoritative. Thus, in the case of the breakdown of uranium during the past year, the early tentative questionings came from Rome; they were caught up at Berlin, were eagerly heard at Paris and Copenhagen and then spanned the Atlantic and were seized upon here so enthusiastically that literally within hours, rather than within days, the critical experiments had been checked and extended at Columbia University, at the Carnegie Institution of Washington and in Lawrence's laboratory at the University of California.

Similarly, the amazing development and application of sulfanilamide—that beneficent gift to mankind—has been the result of a collaboration in which flags and boundary lines have been non-existent. The first hint of it was discovered in Germany, oddly enough in connection with the commercial dye industry, and the drug was given the name prontosil. With this