matter of fact, the preëminent investigations of Arndt (and Gessler) Goodwin and Mailey, J. van Laar, R. Lorenz (and Kauffler) Sackur and others have proven this fact experimentally.

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IN COMMEMORATION OF THE CENTENNIAL OF THE PUBLICATION OF THE BERZELIAN SYSTEM OF SYMBOLS.

BY HENRY LEFFMANN.

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Systems for the brief and concise expression of ideas are probably as old as the intellectual activity of the human race. The ancients had systems of shorthand, and Berthelot has shown, in his elaborate edition of the work of the Greek alchemists, that they used a rude system for expressing the composition of substances. Of course, their system has only historic interest, because their knowledge of the composition of most substances was imperfect or entirely wanting. Thus, for a long while, a native alloy of gold and silver was believed to be a distinct metal. Berthelot gives many examples of this early symbolism. A combination of the signs for gold and silver, respectively, that is, the signs for the sun and moon, would indicate an alloy of these metals. In some representations he gives of symbols, from a MS in the celebrated St. Mark's library, gold is represented not by the present day sign of the sun, a circle with a central dot, but by a circle with two lines meeting in a point, resembling very much the conventional fool's cap, but evidently a rude picture of the sun and its rays. Silver is represented by the crescent moon.

Dalton used several signs, derived practically from the circle, as a conventional representation of the atom.

All systems gave way early to that proposed by Berzelius, which was not only simple and self-explanatory, but had the advantage of easy indefinit expansion along the original lines. The vast advantage that this system has for chemists, even if we regard it only as a step towards an international language, seems to me to make worth while some special note on the occasion of the one hundredth anniversary of its publication.

The earliest formal publication of the system, is in Thomson's *Annals of Philosophy*, Volume 2, 1813, p. 443. The paper is a long one, extending through several numbers. It is entitled "*Essay on the Cause of Chemical Proportions, and Some Circumstances Relating to Them, Together with a Short and Easy Method of Expressing Them.*" *By Jacob Berzelius, M.D., F.R.S., Professor of Chemistry in Stockholm.*

The system is developed in the third section of the essay, and I think it will be of interest to transcribe the whole description, as copied by me from the original in the library of the Franklin Institute.

At the close of the essay, a table of elements, symbols, and some constants is given, in which the following departure from the symbols now used are to be noted: Chromium is Ch, tungsten is Tn, iridium is I, platinum is Pl, palladium is Pa, manganese is Ma, magnesium is Ms, sodium is So, potassium is Po. In one portion of the text mercury is given as Hy, but this is doubtless a slip or a typographical error, as in the table the symbol is given as Hg. The table also contain "F" as the symbol for the "fluoric" radicle and the letters "M" and "N" as symbols for the "muriatic" and "nitric" radicle, respectively.

The following is the transcription:

III. On the Chemical Signs and the Method of Employing Them to Express Chemical Proportions.

"When we endeavor to express chemical proportions, we find the neces- "sity of chemical signs. Chemistry has always possessed them, though "hitherto they have been of very little utility. They owed their origin, "no doubt, to the mysterious relation supposed by the alchemists to exist "between the metals and the planets, and to the desire which they had of "expressing themselves in a manner incomprehensible to the public. "The fellow-laborers in the antiphlogistic revolution, published new signs "founded on a reasonable principle, the object of which was that the "signs, like the new names, should be definitions of the compositions of "the substances, and that they should be more easily written than the "names of the substances themselves. But, though we must acknowledge "that these signs were very well contrived and very ingenious, they were "of no use; because it is easier to write an abbreviated word than to draw "a figure, which has but little analogy with letters, and which, to be "legible, must be made of larger size than our ordinary writing. In pro- "posing new chemical signs, I shall endeavor to avoid the inconvenience "which rendered the old ones of little utility. I must observe here that "the object of the new signs is not that, like the old ones, they should be "employed to label vessels in the laboratory; they are destined solely to "facilitate the expression of chemical proportions and to enable us to "indicate, without long periphrases, the relative number of volumes of "the different constituents contained in each compound body. By de- "termining the weight of the elementary volumes, these figures will en- "able us to express the numeric result of an analysis as simply, and in a "manner as easily remembered, as the algebraic formulas in mechanical "philosophy.

" The chemical signs ought to be letters for the greater facility of writ- "ing, and not to disfigure a printed book. Though this last circum- "stance may not appear of any great importance, it ought to be avoided "whenever it can be done. I shall take, therefore, for the chemical "sign, the *initial letter of the Latin name of each elementary substance;* but "as several have the same initial letter, I shall distinguish them in the "following manner: 1. In the class which I call *metalloids*, I shall employ "the initial letter only, even when the letter is common to the metalloid "and some metal. 2. In the class of metals, I shall distinguish those that "have the same initial with another metal or a metalloid, by writing the "first two letters of the word. 3. If the first two letters be common to two "metals, I shall, in that case, add to the initial letter the first consonant "which they have not in common; for example, S = sulphur, Si = silicium, "St = stibium (antimony), Sn = stannum (tin), C = carbonicum, Co = "cobaltum (cobalt), Cu = cuprum (copper), O = oxygen, Os = osmium, etc.

" The chemical signs express always one volume of the substance. "When it is necessary to indicate several volumes it is done by adding the "number of volumes; for example, the *oxidium cuprosum* (protoxide of "copper) is composed of a volume of oxygen and a volume of metal, "therefore, its sign is Cu + O. The *oxidum cupricum* (peroxide of cop-"per) is composed of 1 volume of metal and 2 volumes of oxygen, there-"fore its sign is Cu + 2O. In like manner the sign for sulphuric acid "is S + 3O; for carbonic acid, C + 2O; for water, 2H + O.

" When we express a compound volume of the first order, we throw "away the +, and place the number of volumes above the letter; for "example, $CuO + S\overset{3}{O}$ = sulphate of copper, $Cu\overset{2}{O} + 2S\overset{3}{O}$ = persulphate "of copper. These formulas have the advantage, that, if we take away "the oxygen, we see at once the ratio between the combustible radicles. "As to the volumes of the second order, it is but rarely of any advantage "to express them by formulas as one volume; but if we wish to express "them in that way, we may do it by using the parenthesis, as is done in "algebraic formulas; for example, alum is composed of 3 volumes of sul-"phate of alumina and 1 volume of sulphate of potash. Its symbol is "$3(Al\overset{2}{O} + 2S\overset{3}{O}) + (Po + 2S\overset{3}{O})$. As to the organic volumes, it is at "present very uncertain how far figures can be successfully employed to "express their composition. We shall have occasion only in the following "pages to express the volume of ammonia. It is 6H + N + O, or $\overset{6}{H}NO$."

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THE DENSITIES OF CERTAIN DILUTE AQUEOUS SOLUTIONS BY A NEW AND PRECISE METHOD.[1]

BY ARTHUR B. LAMB AND R. EDWIN LEE.

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The density of liquids is a sharply defined and exactly measurable property; indeed, it can be determined with greater relative accuracy

[1] Presented in part by R. Edwin Lee, as a thesis for the Degree of Doctor of Science at New York University.