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ing in amethyst and emerald; and I have also less confidence in the measurements for these two substances than for the others. The mica, selenite, Iceland spar, and rock crystal, were covered with a varnish of black sealing-wax on their second surfaces, to prevent reflection. Where it is said that the incidence on rock crystal was perpendicular, it must be understood that it was only so nearly so, that the natural unevenness of the facet made it impossible to determine it.

The reflection by selenite is so exceedingly nearly the same as that of crown-glass, that I found it impossible to state with certainty whether it was higher or lower: in one observation, however, I made it higher.

With the other substances, and particularly with mica and Iceland spar, the difference is quite obvious at the first view.

XXXIX. *On the Establishment of some perfect System of Chemical Symbols; with Remarks on Professor Whewell's Paper on that Subject. By Mr. R. WARRINGTON*.*

IN entering upon the consideration of the necessity of chemical symbols,—a necessity which becomes the more urgent from the rapid progress the science is continually making, and from the increasing number of new combinations which are daily brought before our notice, and the want of some system of symbols to facilitate our reasoning upon these and other combinations,—there are two great points to be kept in view; namely, brevity and clearness in the nature of the symbols themselves, and as perfect an approximation to mathematical consistency and algebraic formulæ as the nature of the subject will admit.

Professor Whewell, in a paper upon this subject published in the 1st volume of the *Journal of the Royal Institution* for May 1831, advocates the necessity of radically altering the symbolic system of Berzelius, on account of its total want of mathematical propriety, and fully demonstrates the advantages to be derived from the adoption of an arrangement founded on algebraic principles†.

The improprieties more particularly pointed out in Berzelius's system of notation are; first, the method adopted by him of connecting the elementary symbols together in representing compound bodies, as though, according to the notation made use of in algebraic reasoning, the constituents were multiplied by each other; whereas the combination is effected by

* Communicated by the Author.

† In the *Phil. Mag. and Annals*, N.S., vol. x. p. 104, appeared a paper on *Chemical Symbols and Notation* by Mr. Prideaux, in reply to Professor Whewell, a brief rejoinder from whom will be found in the same volume. p. 405, note.—EDIT.

the simple union or addition of the elements. As for instance, in Sulphuret of Potassium, one proportion of sulphur is added and chemically united to one proportion of potassium (*kalium*), which should be indicated by $S + K$, Sulphur + Kalium; but according to Berzelius's arrangement it would be written SK , in which the components are apparently multiplied by each other; and this, to use Professor Whewell's words (p. 441), "violates all mathematical propriety so entirely, that it must always be disagreeable to see an example of it for any person who has acquired the first rudiments of algebra."

The next point of consequence commented on, is the manner of representing compounds which contain more than one proportion of an elementary or compound body, and to which the prefixes, Bis, Tris, Dis, &c. have been given. The method pursued by Berzelius, is to place the numerals 2, 3, 4, &c. as indices over the symbol corresponding to the element, acid, or base: thus Bisulphuret of Iron, composed of two proportions of sulphur + one of iron, would be written $S^2 Fe$; Bisilicate of Alumina, $\dot{S}^2 A$; Bisulphate of Copper, $\ddot{S}^2 Cu$; Disul-

phate of the Peroxide of Iron, $\ddot{S}^2 Fe^2$. To obviate these incongruities, and to lay before the chemical world a system formed on mathematical principles and consistent with algebraic formulæ, appears to have been the object intended by Professor Whewell in his paper: but in this he appears to me to have failed, not for want of due consideration and ability, but from the subject having been taken up in a mineralogical rather than a chemical point of view; for the Professor himself acknowledges, speaking of the proposed system (p. 448), that "the preceding notation is intended principally for the purposes of mineralogy;" and that "in the calculations of chemistry it would be necessary to have some additional contrivances. Thus it would be proper, as I have already observed, to indicate the mode in which both the oxides and the acids are formed from their bases by the addition of definite portions of oxygen." On attentively reviewing this part of the subject, I cannot help forming the conclusion, that these continual contrivances and contractions to suit different points of reasoning, must involve the subject in interminable confusion and difficulty. It would, I should consider, be far simpler to adopt one entire set of symbols applicable to all branches of chemical science, or to other sciences into which chemical reasoning may enter. If some arrangement of this kind is not fixed upon, the subject will be continually open to variation, and the caprice of different persons according to their several ideas of symbolic notation.

It is with the view of furthering the ultimate and, I hope, speedy establishment of some one systematic arrangement, that I have been induced to occupy a short space in your valuable Journal with the present paper, which, although the system promulgated in it should not be perfect, may yet be of service, as affording some useful hints to others more fitted for the final settlement of this most desirable and useful object.

On the first consideration of this subject, I was led to imagine that abbreviations of the English nomenclature would be more simple to the English student, and would be more readily understood and applied by him; but upon further reflection I was convinced that the Latin symbols, as selected by Berzelius, would be far preferable, on account of their having been in frequent use, more particularly among the Continental chemists and mineralogists, for some years, and also from their conciseness and simplicity. But (with one exception, which will be stated hereafter,) nothing more, I think, of Berzelius's system should be adopted, than the symbols of the elementary bodies. In the connection of these elements with each other, the methods generally adopted by Sir John F. W. Herschel, and subsequently followed by Professor Whewell in its principal features,—namely, the plus signs for the formation of compounds, and the use of brackets or ties,—must be taken to form the basis of a system with any claims to mathematical consistency:—an example will show more clearly the method according to which these are employed. Take, for instance, the octohedral copper pyrites, composed of two proportions of sulphuret of copper and one proportion of sulphuret of iron; this will be indicated thus, $2(S + Cu) + (S + Fe)$. Although this part of the subject has been cursorily alluded to in the former part of this paper, and the arguments used by Prof. Whewell briefly stated, yet I cannot avoid noticing in this place, that in a subsequent part of Professor Whewell's essay, he appears to have entirely forgotten the severe strictures that he had passed on Berzelius as to the want of algebraic consistency; and also his own observation (page 442), that “the combinations of ingredients which make up compounds are clearly of the nature of additions, and never can have any analogy with the multiplication of the numbers expressing the components; they therefore ought by no means to be represented by that combination of symbols which denotes multiplication.” And again, at the 18th line of the same page, “there can be no doubt of the exceeding impropriety, I might say absurdity, of such a kind of symbols.” Now, in direct contradiction to these observations, Professor Whewell proposes to represent the oxides of

the metals (p. 449) "by repeating the second letter of the symbol for each additional atom of oxygen, and attaching s (semisis) for the half atom : thus, Mn, Mns, Mnn, are the Protoxide, Deutoxide, and Peroxide of Manganese." Again, in objecting to the use of dots placed over the symbolic letters for the indication of the number of proportions of oxygen in any compound, it is admitted (p. 149) "that the notation is compact and simple," but "that it is not consistent with algebraic rule, as far as the oxygen is concerned ;" and the writer argues, "that to be explicitly expressed, it should be done in the manner previously recommended, as $fe + 20$, $fe + 30$, Protoxide and Peroxide of Iron," according to Berzelius's view of those combinations. Now, on referring back to the preceding page, we find Professor Whewell urging the utility of representing the Acids commonly occurring in minerals, by an accent or dash placed over the bases of the acid : thus, for instance, S Sulphur, S' Sulphuric Acid ; C Carbon, C' Carbonic Acid ; Ar Arsenic, Ar' Arsenic Acid ; Cr Chromium, Cr' Chromic Acid ; Cl Chlorine, Cl' Muriatic Acid ; I Iodine, I' Hydriodic Acid. And at the concluding part of the paper this system is extended to other combinations of oxygen with the same bases, the accent being varied : as S' Sulphurous Acid, C' Carbonic Oxide, Ar' Arsenious Acid. But in this arrangement no notice appears to have been taken of acids the basis of which combines with both oxygen and hydrogen, as is the case with chlorine, iodine, bromine, fluorine, sulphur, &c. The chloric acid must be indicated in the same way as the muriatic, the iodic as the hydriodic, sulphuretted hydrogen in combination as an acid the same as sulphuric acid, and so of the rest. Then we have also the perchloric acid, for which it would be necessary to form some other accent or distinguishing mark. Considering this subject impartially, it must be allowed, that Berzelius's arrangement, with respect to the representing oxygen by dots, if examined even in an algebraic point of view, is more simple and correct than the various accents made use of by Professor Whewell, each of which represents oxygen or hydrogen quite as fully as the dots indicate oxygen alone ; and that no clew is afforded by this method as to the elementary bodies or their proportions which enter into the composition of a compound, but simply, that it is a union of an acid with a base, &c., and that it may be sometimes even doubtful what the nature of that acid is,—whether the acidifying principle be oxygen or hydrogen. Besides these contractions, there are others introduced equally objectionable ; such as the representing the Metals by small letters, and their Oxides by the same letters, commencing with the large Roman character ; as z^n Zinc, Zn

Oxide of Zinc; and also the indication of silica, alumina, and the other earths, by the symbolic letters of their individual bases, as S, A, &c.; and again with ammonia and water, they are respectively represented by the abbreviation Am, and the letter q. Professor Whewell states that these contrivances and contractions are to be considered as mere abbreviations, very convenient, but not indispensably necessary. If not so, why are they introduced? But the strict reason I imagine to be, that from Prof. Whewell's wishing to render the system perfectly mathematical, the different formulæ must necessarily be very extended, and therefore inconvenient. I consider these abbreviations uncalled for, however, and that they must add materially to the rendering any system of symbolic notation intricate and confused. The representation of oxygen by dots appears to simplify the subject, and render the formulæ very brief; and it clearly shows at the first glance the number of proportions of oxygen which enter into combinations, without at all confusing the arrangement, or rendering other contractions for the representation of the oxides or oxacids necessary, and it has therefore been adopted in the present system. I also propose introducing other dashes or marks to represent chlorine, iodine, bromine, fluorine, and nitrogen; for in the combinations of nitrogen with hydrogen and carbon, separately or conjointly,—as in ammonia, cyanogen, and their compounds,—this latter will be found of very great service. The way in which I should introduce these would be as follows: H' one proportion of Hydrogen and one of Oxygen will represent water, the dot, as in the system of Berzelius, indicating the oxygen; H' Hydrochloric or Muriatic Acid, the vertical dash indicating Chlorine; H' Hydrobromic Acid, the acute dash being Bromine; H' Hydriodic Acid, the grave dash for Iodine; $\overline{\text{H}}$ Hydrofluoric Acid, the horizontal stroke representing Fluorine; and (\S H). Ammonia, the dot beneath the symbols indicating Nitrogen; but in case this formula should not appear applicable, the one $\overline{3\text{H} + \text{n}}$ may be adopted. With respect to the half proportions, these may be readily and conveniently represented by making a fraction of the mark or accent thus: Fe, Fe $\bar{\cdot}$, Fe $\bar{\cdot\cdot}$ will be Iron, its Protoxide, and Peroxide. m., m', m' $\bar{\cdot}$, m' $\bar{\cdot\cdot}$ Manganese, its Protoxide, Deutoxide, and Peroxide.

I fear that this introduction of accents and fractional accents will be condemned by those who wish to establish a system on pure algebraic reasoning. But I doubt very much whether a system can be so established without rendering the formulæ very extended, and in fact superseding the use of

symbols altogether, the beauty of which must always consist in their simplicity, clearness, and brevity. I shall annex some examples of the three methods; those of Berzelius, and Whewell, and the one here proposed; and leave the subject, I hope to be established speedily, by some one fully equal to the task.

O. Oxygen.	G. Glucinum.	W. Tungsten, Wolframium.
Cl. Chlorine.	Y. Yttrium.	Cr. Cerium.
Br. Bromine.	Th. Thorium.	Ni. Nickel.
I. Iodine.	Zr. Zirconium.	Co. Cobalt.
F. Fluorine.	Al. Aluminum.	V. Vanadium.
N. Nitrogen.	Si. Silicum.	Cr. Chromium.
H. Hydrogen.	M. Manganese.	Ta. Columbium,
C. Carbon.	Fe. Iron, Ferrum.	Tantalum.
S. Sulphur.	Zn. Zinc.	Hg. Mercury, Hydrargyrum.
P. Phosphorus.	Cd. Cadmium.	Ag. Silver, Argentum.
Se. Selenium.	Sn. Tin, Stannum.	Au. Gold, Aurum.
B. Boron. [sium.	Sb. Antimony, Stibium.	Pt. Platinum.
K. Kalium, Potas-	As. Arsenic. [bium.	Pd. Palladium.
Na. Natrium, So-	Bi. Bismuth.	R. Rhodium.
Li. Lithium. [dium.	Pb. Lead, Plumbum.	Ir. Iridium.
Ba. Barium.	Cu. Copper, Cuprum.	Os. Osmium.
Sr. Strontium.	Te. Tellurium.	
Ca. Calcium.	Ti. Titanium.	
Mg. Magnesium.	Mo. Molybdenum.	

*Chloride of Sodium.**Nitrate of Potash.*

Berzelius.....	Cl Na	$\ddot{N} \ddot{K}$
Whewell.....	cl + na	$(n + 50) + (K + o)$
Proposed System	N^I	$\ddot{N} + \ddot{K}$

*Nitrate of Ammonia.**Muriate of Baryta.*

Berzelius.....	$NH^3 \ddot{N} + \ddot{H}$	$Cl H Ba + \ddot{H}$
Whewell.....	$(n + 3n) + (n + 50) + (h + o)$	$(cl + h) + (ba + o) + (o + h)$
Proposed System	$(3H). + \ddot{N} + \ddot{H}$	$H + Ba + \ddot{H}$

Or the same in another view,

*Muriate of Baryta.**Alum.*

Berzelius...	$ClB + 2\ddot{H}$	$\ddot{K} \ddot{S} + al^3 \ddot{S}^3 + 25\ddot{H}$
Whewell	$(cl + b) + 2(h + o)$	$(K + o + S + 30) + 3(al + o + S + 50) + 25(o + h)$
Prop. Syst.	$Cl + B + 2\ddot{H}$	$(K + \ddot{S}) + 3(al + \ddot{S}) + 25H$
or,	$B^I + 2H$	

Hydrocyanate of Ammonia.

Berzelius.....	$\text{NH}^3\text{Hc}^3\text{N}$
Whewell.....	$(n + 3\text{H}) + (\overline{2c + n + h})$
Proposed System...	$(3\text{H}). + (\overline{2c}). + \text{H}$

Persulphate of Iron and Potash.

Berzelius.....	$2\text{S}^{\text{I}}\text{I}\frac{1}{2}\text{Fe}^{\text{I}} + \text{S}^{\text{I}}\text{K}^{\text{I}} + 25\text{H}^{\text{I}}$
Whewell.....	$2(\overline{1\frac{1}{2}\text{S} + 4\frac{1}{2}\text{o} + \text{fe} + \frac{1}{3}\text{o}}) + (\overline{\text{S} + 30 + \text{Ka} + \text{o}}) + 25(\text{h} + \text{o})$
Proposed Syst.	$2(1\frac{1}{2}\text{S}^{\text{I}} + \text{Fe}^{\text{I}}) + \text{S}^{\text{I}} + \text{Ka}^{\text{I}} + 25\text{H}^{\text{I}}$

Ferrocyanate of Potash.

Cyanate of Lead.

Berzelius...	$2\text{c}^2\text{NK} + \text{c}^2\text{NFe} + 3\text{H}^{\text{I}}$	$\text{C}^2\text{No P.b}^{\text{I}}$
Whewell	$2(\overline{2c + n + K}) + (\overline{2c + n + Fe}) + 3(\text{h} + \text{o})$	$(\overline{2c + n + o}) + (\text{pb} + \text{o})$
Prop. Syst.	$2((2c). + K) + ((2c). + Fe) + 3\text{H}^{\text{I}}$	$(\overline{2C}). + \text{o} + \text{Pb}^{\text{I}}$

Ammoniacal Alum.

Berzelius	$3\text{al}^{\text{I}}\text{S}^{\text{I}} + \text{NH}^3\text{S}^{\text{I}}$
Whewell.....	$3(\overline{\text{al} + \text{o} + \text{s} + 30}) + (\overline{n + 3\text{h} + \text{s} + 30})$
Proposed System...	$3(\text{al}^{\text{I}} + \text{S}^{\text{I}}) + ((3\text{H}). + \text{S}^{\text{I}})$

30, Church-street, Spitalfields, July 1832.

XL. Tabular Abstract of the Results of Capt. Lloyd's Leveling from the Sea near Sheerness to the River Thames at London Bridge. By B. BEVANS, Esq.

To the Editors of the Philosophical Magazine and Journal.

Gentlemen,

CAPT. LLOYD's paper, as published in the Philosophical Transactions for 1831, which shows that the brass standard at the landing-place of New London Bridge is 2.3967 feet below an arbitrary mark at Sheerness, contains little information relative to the longitudinal section of the river Thames itself, either as to the surface of the water at high, mean, or low state; and which, in a philosophical point of view, would have been very interesting*. Most tidal rivers have the high-water mark at the outlet considerably *higher* than at a distance of some miles up the river, particularly when the country is flat, or almost level, through which the river passes; whereas it appears by these

* An abstract of Capt. Lloyd's paper, including a brief account of the apparatus and methods employed, was given in Phil. Mag. and Annals, N.S., vol. ix. p. 357.—EDIT.