

THE
AMERICAN JOURNAL
OF
SCIENCE AND ARTS.

CONDUCTED BY
PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,
AND
JAMES D. DANA,

IN CONNECTION WITH
PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK,
PROF. S. W. JOHNSON, OF NEW HAVEN,
PROF. GEO. J. BRUSH, OF NEW HAVEN.

SECOND SERIES.
VOL. XXXV.—MAY, 1863.

WITH A MAP.

NEW HAVEN: EDITORS.
1863.

PRINTED BY E. HAYES, 425 CHAPEL ST.

TEXAS TECHNOLOGICAL COLLEGE LIBRARY
LUBBOCK, TEXAS

P

00011

ART. XII.—*The Chemical Theory of Interpenetration*; by CHARLES S. PEIRCE, A.M.

PHYSICISTS are now rapidly doing away with all theories which demand peculiar shapes and kinds of matter in favor of those which demand peculiar vibrations. At this day, the arrow-shaped particles of the old theory of light seem grotesque. There is a good reason for this tendency. We require an explanation of forces. Now a force is only a mathematical function of a change, and a change in space can only be conceived of *a priori* as a motion. To explain a thing is to bring it into the realm of our *a priori* conceptions. Hence, whenever we endeavor to explain any force of nature by means of hypothetical shapes and properties of matter these only help us so far as they are conditions of certain motions. These motions are the real explanation; and if we can succeed in getting the motions without the peculiarities of matter, our hypothesis will be so much the smaller.

The object of the present article is to apply this principle to the Atomic Theory.

I. In the first place, it is necessary to show that the hypothesis of atoms, in itself, explains nothing.

That which the atomic theory undertakes to explain is the connection of integral numbers with chemical equivalents.

An explanatory hypothesis is one which, being admitted, necessitates all the phenomena. The laws to be explained are as follows:

1. The Law of Equivalents, or that if x units of one body combine with x of a second and y of a third; and if x of that second combines with b of a fourth, that y of the third will also combine with b of the fourth.

The explanation is that these are the weights of the atoms and that bodies combine atom by atom. But how should we know that they combine atom by atom? This is an addition to the hypothesis.

2. The Law of Multiple proportions.

How should we know that atoms will mix in any simpler ratios than black and white beans would if stirred up together?

3. The Law of Combining Volumes of Gases.

The explanation is that the atoms of all gases are equally distant. A new hypothesis.

4. The Law of Volumes of Isomorphous Crystals. Another hypothesis needed.

5. The Law of Thermal Equivalents of the Elements.

Explanation: All atoms have the same capacity for heat. Still another hypothesis, which moreover does not apply to compounds.

6. The Thermal Equivalents of Isomorphous Crystals.

7. Kopp's Law of Boiling points. How is this explained?

8. Prout's Law as modified by Dumas.

The only atomic weights which have been determined with sufficient accuracy to test the law, beside those of Stas, are the following:—

Carbon 6.01 Berzelius; 6.00 Dumas and Stas; 6.00 Erdmann and Marchand; 6.06 Liebig and Redtenbacher; 6.03 Strecker. C is not more than 6.004.

Lithium, Diehl 7.026 (prob. error ± 0.03); Troost 7.01, Mallet (S=16.03, Na=23.05, Mg=12.0125) 7.027. Mean 7.02.

Calcium 20.002 (C=6.004) Erdmann and Marchand.

With less accuracy we have

Iron, Svanberg and Norlin (after rejecting two discordant experiments according to Peirce's criterion) 28.048; Berzelius, 28.024; Erdmann and Marchand, 28.012; Maumené, 28.000. Mean 28.017.

Combining the first three atomic weights with those determined by Stas, we have:—

	Experiment.	Law.	Difference.	Dif. ÷ Exp.
K	39.154	39.25	-.096	$\frac{1}{410}$
Na	23.05	23	+.05	$\frac{1}{460}$
Ag	107.94	108	-.06	$\frac{1}{1799}$
Pb	103.45	103.5	-.05	$\frac{1}{2069}$
Cl	35.46	35.5	-.04	$\frac{1}{886}$
N	14.04	14	+.04	$\frac{1}{351}$
S	16.03	16	+.03	$\frac{1}{533}$
H	1.005	1	+.005	$\frac{1}{200}$
Li	7.02	7	+.02	$\frac{1}{351}$
Ca	20.002	20	+.002	$\frac{1}{10000}$
C	6.004	6	+.004	$\frac{1}{1500}$

K is an unexplained anomaly, but the probability of only one difference out of thirteen being greater than $\frac{1}{410}$ is .0000087, while the effect of the residual influence which carries K out of this limit is only $\frac{1}{1799}$ of the atomic weight. Omitting K, the sum of the above differences is +.001; the probability of this being so small is .035; hence, upon this consideration, the probability of the law is .782.

The probability is, therefore, still in favor of the law. The last column in the table shows how small the residual phenomena are; and they may be made still smaller by making the unit by which the atomic weights are measured a little larger.

This law presents another example of the connection between chemical equivalents and integral numbers, and must probably be capable of a common explanation with the rest. Yet it is clear that the atomic hypothesis never can explain it.

9. It is impossible for the atomic theory to explain why the monoatomic radicles combine together without condensation in the gaseous form; while the diatomic radicles lose their own volume, the triatomic one more than their own volume, &c., in combining with the monoatomic. Why in acetic ether, for example, $\left. \begin{matrix} \Theta \cdot \text{CH}_2 \cdot \text{H} \\ 2\text{CH}_2 \cdot \text{H} \end{matrix} \right\} \Theta$ the dibasic radicles occupy no space at all.

II. I shall now attempt to show that the facts of chemistry are explicable by the view of Kant, that matter is not absolutely impenetrable and that chemical union consists in the interpenetration of the constituents.

1. The law of definite proportions is capable of demonstration without any hypothesis. We can conceive of no event in space which does not consist of a motion. Nothing can be the cause of a motion except a motion; hence every force is a motion. And every quality of matter is either a motion or some element of the mental analysis of the conception of a body moving in some way or other. Hence, when the force of one body acts on the quality of another to produce an event, it is merely one motion modifying a second to produce a third. Motion is never stationary, but always communicates itself from the moving particle to all others which are in communication with that. Accordingly, when one body acts on another *through a difference of quality*, the latter will also act on the former and there will be a tendency to produce homogeneity of quality throughout the two. This homogeneity is actually established, or it is not. If it is not, the amount of force which holds back the two forces from their natural action must be just as strong as the forces themselves. It is clear, therefore, that when the force of the acting body equals that of the body acted upon, all the force will be exhausted in preventing the homogeneity. Probably, however, it might be proved that the homogeneity is always established; and if it is, it cannot be established through both motions existing at the same time without interference. For, if they had not interfered, they could not have acted upon one another. They must, therefore, destroy each other (producing a new motion) and when they are equal the peculiarities by which they acted will be neutralized and there will be no further action. Now the same kind of matter under the same dynamical conditions possesses always the same amount of force proportionally to its mass; hence when one kind of matter acts on another through being of a different kind, it can only act on a definite amount of that matter, the dynamical circumstances remaining the same.

2. Let us call the reciprocal of the Atomic Weight the Chemical Intensity. This represents the force which causes bodies to combine. It remains the same under all dynamical circumstances.

ces. Hence, it must be something inherent in matter and unaffected by all vibrations. In gases it is proportional to the elasticity, and in elementary bodies generally it is equal to the specific heat, which is the elasticity of the medium of heat-vibrations. We conclude, then, that the Chemical Intensity is the molecular or substantive elasticity. (B. Peirce.)

When heat expands the body, it is the elasticity which restores it. Any motions of vibration in a homogeneous elastic medium may be resolved into expansions and contractions. Hence, if we assume that heat produces the expansions, this elasticity is an active condensing force.

If two bodies interpenetrate it is clear that this force may hold them together. This explains the law of definite proportions, the law of vapor densities, and the law of thermal equivalents.

3. It is geometrically self-evident that interpenetration must take place between equal volumes and must result in a condensation to one half, unless some other action takes place. Accordingly we find that wherever there is no condensation there is only a double decomposition.

4. In one volume of a compound there is one equivalent of chemical intensity. Hence there is nothing to prevent its combining with one volume more, &c. This explains the law of multiple proportions, which it is to be observed has no place where the bodies unite without condensation.

5. The solid and liquid states result from the action of cohesion. Now cohesion is an attraction properly so called and acts at a distance, for if it did not it would not vary with the state of condensation. Hence it is a force affecting molecules and not matter in its continuity. This explains why the above reasonings from the state of gases are not invalidated by the facts relating to liquids and solids.

6. If we suppose, with the metaphysicians, that all the kinds of matter are derived from one, since this must have become condensed by the law of equal volumes, all the equivalents of the elements will be multiples of that of the original matter. This explains Prout's law. If, moreover, we admit that the different elements are distinguished by different elasticities, and accept the recent view that the lines of the spectroscopic are only produced by elements in their free state, it will follow that every element except sodium is a mixture of several. We have no reason to suppose that these are present in equivalent proportions. So that this consideration gives room for large discrepancies from Prout's law.

7. It is observable that tribasic radicles frequently behave like monobasic ones, as N in $\left. \begin{matrix} \text{C}_2\text{H}_2(\text{N}\Theta_2)\Theta \\ \text{H} \end{matrix} \right\} \Theta$ and in $\left. \begin{matrix} \text{H} \\ \text{N}\Theta_2 \end{matrix} \right\} \Theta_2$, and that monobasic radicles frequently behave like tribasic ones,

as Cl in ICl_3 . There is the same confusion between dibasic and tetrabasic radicles, as in CO. Hence we infer that the distinction between even and odd-basic is altogether superior to that between monobasic and tribasic, dibasic and tetrabasic.

Now if a body can enter into double decomposition with hydrogen (that is, combine without condensation) it is obvious that it must be odd-basic; for in that case it will form a compound which being of two volumes cannot combine with another volume of H unless it combines with two volumes. If it does thus combine it will be tribasic, otherwise monobasic.

On the other hand, if a body cannot enter into double decomposition with the monobasic radicles, it must be even-basic; for in this case, since its volume after combination will be the same as before, there is no reason why it should not either combine with condensation with a new volume of the monobasic radicle (in which case it will be four or more basic) or else enter into double decomposition with it, in which case it will be dibasic. This explains why the dibasic radicles always lose their own volume in combining with the monobasic; why the tribasic lose twice their own volume, &c.

8. A radicle being a constituent in combination, it follows that its internal forces do not come to equilibrium of themselves, and this accounts for the fact that monobasic radicles cannot exist free. This fact is determined by reactions and not by vapor-density, for according to the present theory the volume fixes neither the atom nor the molecule but the *equivalent*, that is to say, the amount of matter containing a unit of chemical intensity. The dibasic radicles may exist in the free state because, since in combining they are condensed, it follows that there is some disturbance of their internal forces.

9. An odd-basic radicle being in itself out of equilibrium in this way, it follows that the addition of it to another radicle will change the basicity of that radicle from odd to even or from even to odd; while the addition of an even-basic radicle will have no such effect.

Cambridge, Mass., Dec. 1862.

ART. XIII.—*Exposition of the true nature of Pleurodyctium problematicum*; by CARL ROMINGER, M. D.

UNDER the above name I have long kept in my cabinet a specimen, collected at Kirchweiler in the Eifel mountains. After having identified it with the fossil described by Goldfuss, I laid it aside, and only recently, twenty years afterwards, when I happened to look over it again, the first glance convinced me that the *Pleurodyctium problematicum* is merely the cap of a *Tavo*.

P

C0012