CHEMISTRY-PHYSICS

Last of the Phlogistonists

"A Classic of Science"

Priestley, Preferring the Older Theory, Realized That Ideas Important to Him Might But Amuse His Followers

EXPERIMENTS AND OBSERVATIONS ON DIFFERENT KINDS OF AIR, and other branches of Natural Philosophy connected with the subject. In Three Volumes; being the former Six Volumes abridged and methodized, with many Additions. By Joseph Priestley. Birmingham, Printed by Thomas Pearson; MDCCXC. (1790). *This is an exact reprint of extracts from the original publication.*

IT IS ALWAYS our endeavour, after making experiments, to *generalize* the conclusions we draw from them, and by this means to form a *theory,* or *system of principles,* to which all the *facts* may be reduced, and by means of which we may be able to foretel the result of future experiments. With a view to this it has of late been a great object with philosophers to ascertain the number of *elements* that are necessary to constitute all the substances with which we are acquainted, and especially the different kinds of air, to which our attention has been much directed, in consequence of their seeming to bring us a little nearer to the ultimate constituent parts of bodies; finding that by their union they are capable of forming solid masses.

In my former publications I have frequently promised, and sometimes attempted, to give such a general theory of the experiments in which the different kinds of air are concerned as the present state of our knowledge of them enabled me to do, and I cannot well decline attempting something of the same kind in this new edition of all I have published before; though I acknowledge that I am very far from being able to satisfy myself with respect to it, and therefore cannot expect to give much satisfaction to others. When I published the first of my six volumes, I was not aware of much difficulty on this subject, but new experiments soon unhinged whatever I had thought best established; and this has been so often the case, that my diffidence increases in full proportion to the increase of our knowledge.

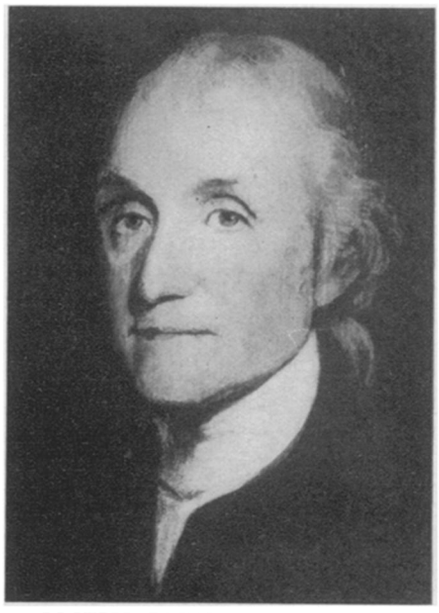
Fluctuating, however, as the present state of this branch of knowledge is, I shall not decline to give my present views of it; nor shall I find any more difficulty in retracting any opinion I shall now advance, than I have hitherto done in retracting what I have advanced before. The sketch that I shall now give may at least serve, like former theories, to amuse us when we look back upon it, after having gained a more perfect knowledge of the subject.

According to my latest observations, *water,* or rather *vapour,* is the basis of all kinds of air, or that to which they owe their peculiar kind of *elasticity;* so that all kinds of air may be said to be vapour with something else so attached to it, as to prevent its condensation in the temperature of the atmosphere.

The most simple of all the kinds of air are the *inflammable* and *dephlogisticated;* the former consisting of water and phlogiston, and the latter of water and something that may be called the *principle of acidity,* as it appears to be necessary to the constitution of all acids. Water seems to constitute about nine parts in ten of dephlogisticated air, but there seems to be a much less proportion of it in inflammable air. . . .

The Doctrine of Phlogiston

According to Stahl, phlogiston is a real substance, capable of being transferred from one body to another, its presence or absence making a remarkable difference in the properties of bodies, whether it add to their weight, or not. Thus he concluded that oil of vitriol deprived of water, and united to phlogiston, becomes sulphur, and that the calces of metals, by the addition of the same substance, become metals. The air that has since been discovered in the calces of metals, make no great difference in the system. For as oil of vitriol must part with its water, as well as imbibe phlogiston, in order to its becoming sulphur, so the calx must part with its air, as well as imbibe phlogiston, in order to become a metal.



JOSEPH PRIESTLEY, 1733-1804

What is now contended for is, that in the oil of vitriol changing into sulphur, something is *lost,* and nothing *gained;* and also that a calx becomes a metal by the loss of air only. And did facts correspond on this theory, it would certainly be preferable to that of Stahl, as being more *simple;* there being one principle less to take into our account in explaining the changes of bodies. But I do not know of any case in which phlogiston has been supposed to enter into a body, but where there is room to suppose that *something* does enter into it.

What has been insisted upon, as most favourable to the exclusion of phlogiston, is the revival of mercury, without the addition of any other substance, from the *precipitate per se.* In this case it is evident that mere *heat,* either in a close retort, or in vacuo, is sufficient to revive the metal. And as what is expelled from this calx is the purest dephlogisticated air, it has been said that mercury is changed into this calx by imbibing pure air, and therefore becomes a metal again mere- (*Turn Page*)

ly in consequence of parting with that air.

But Mr. Kirwan explains this case in the following manner, which to me appears satisfactory. The metal, when exposed to a certain degree of heat, in contact with pure air, imbibes indeed the pure air, and nothing else, retaining the whole of its own phlogiston; so that then it may be said to contain fixed air, which is composed of phlogiston and dephlogisticated air; and that in a greater degree of heat, the latter is expelled while the former is retained; so that this calx was always possessed of phlogiston sufficient for its own revival.

But that mercury may be deprived of its phlogiston, so as to be incapable of becoming running mercury again by mere heat, is evident from my experiments on *turbith mineral.* For if this substance be exposed to heat in a very clean earthen vessel, the vitriolic acid so effectually carries away its phlogiston, that a great proportion of it is left a mere calx, capable of bearing any degree of heat without revival; and it can never become running mercury again, but by being heated in contact with inflammable air, or some other substance containing phlogiston. It is evident, therefore, that this calx, which is a dark red substance, sometimes hard, and sometimes powdery, is mercury deprived of its phlogiston, and something must enter into it before it can become a metal. Consequently, the metals are not simple substances, but phlogiston always enters into their composition. This, indeed, is evident from those of my experiments in which I produce any of the metals from the calces, by heating them in inflammable air, which is imbibed by them.

Mons. Lavoisier, and many who follow him, are of opinion that what has been called phlogiston, is nothing more than one of the constituent parts of water, the other being the *principle of acidity;* and this doctrine of the composition and decomposition of water, has been made the basis of an entirely new system of chemistry, and a new set of terms has been invented, and appropriated to it.

It must be acknowledged, that substances possessed of very different properties, may, as I have said, be composed of the same elements in different proportions, and different modes of combination. It cannot therefore be said to be absolutely *impossible* but that water may be composed of these two elements, or of any other; but then the supposition should not be admitted without *proof;* and if a former theory will sufficiently account for all the *facts,* there is no occasion to have recourse to a new one attended with no peculiar advantage.

Joseph Priestley was born 200 years ago, March 31, 1733. He was a Nonconformist in religion and an independent investigator in science. In chemical theory he followed Stahl and the "doctrine" of phlogiston instead of his contemporary Lavoisier and the theories of oxidation which have survived. Yet this statement of his beliefs shows him as still holding the scientific attitude of mind as well as the misleading theory would let him. Priestley's discovery of fixed air (carbon dioxide) was published as the Classic of Science in the SCIENCE NEWS LETTER of Dec. 24, 1927 and his discovery of nitrogen as the residual gas when air is "diminished" by combustion as the Classic of Science in the SCIENCE NEWS LETTER of Aug. 13, 1932. His discovery of oxygen will appear in its place in the series of Classics on the history of the chemical elements.

Science News Letter, March 11, 1933

SEISMOLOGY

New Quake in Same Deep As Great Shock of 1923

JAPAN'S newest misfortune, the earthquake that brought death and destruction and tidal wave on Thursday, March 2, was born of the same geologic conditions that caused the even greater disaster of Sept. 1, 1923, when thousands of lives were snuffed out in the crowded cities of Tokyo and Nagaaki and the general region around Sagami Bay. The epicenter of the recent earthquake was located fully five hundred miles to the north, but it lies in the same submarine valley, known to oceanographers as Tuscarora Deep, which has its southern end in Sagami Bay. Furthermore, the tidal wave that swept down on the coast of Japan was probably caused by the same kind of earth movement, a sudden drop of a part of the bottom of this valley which started the disturbance in the water and sent it sweeping toward the helpless towns on the shore.

As soon as the earthquake occurred, seismographs in all parts of the world registered its distance and indicated that it was very severe. These data, collected by wire and radio by Science Service, were decoded by scientists of the U. S. Coast and Geodetic Survey. They gave the exact moment of the beginning of the quake as 12:31.2 p. m., eastern standard time, and the location of the epicenter as 39.5 degrees north latitude, 143.5 degrees east longitude. This is a point about 100 miles east of the north end of Honshu, principal island in the Japanese group.

Science News Letter, March 11, 1933

CHEMISTRY

Cheap Chemical Prevents Rancidity in Oils and Fats

MALEIC ACID, a cheaply and easily produced synthetic compound, has been found to be a good thing to add to edible fats and oils to keep them from getting rancid. Dr. G. R. Greenbank of the U. S. Department of Agriculture, who made the discovery, has applied for a public service patent on its use for this and similar purposes. Under such a patent, the product can be used freely by anybody, and no one can establish a monopoly.

Dr. Greenbank was led to his discovery by a project in chemical research, with the object of finding why some oils and fats kept naturally better than others. He did not succeed in learning this, but did learn that the natural "better keepers" contained minute quantities of unidentified organic acids.

Then he tried adding acids of known composition to oils and fats, and soon found that maleic acid, added in a proportion of one part to ten thousand of the oil to be preserved, would enable it to stand without turning rancid for about three times as long as untreated samples of the same oils.

Dr. Greenbank has tried this method on many fats and oils used as food and in the industries, including butterfat, butter, lard, and the oils of cottonseed, peanuts, corn and sesame. He has also tried it on such food products as milk powder and pie-crust, and he believes it will be useful in the cereal industries.

The chemistry of maleic acid's efficiency in preventing rancidity is not yet known. Dr. Greenbank thinks it possible, however, that it operates by stopping the formation of peroxides, which are intermediate steps in the respirational-digestive processes of the bacteria and other fermentive organisms that oxidizes fats and oils, thereby splitting off the acids that give the rancid odors.

Maleic acid is now made by manufacturers of photographic reagents and sells for a few cents an ounce.

Science News Letter, March 11, 1933