system, so also will a similar direction be given to the effects of external motion. Every motion tending to propel forward the blood, will hence assist the powers of the heart; but such as have a contrary tendency will be resisted by the interposition of the valves, and cannot occasion proportional obstruction to the regular progress of the blood; the heart is thus assisted in the work of restoring a system, which has recently struggled with some violent attack, or allowed, as it were, to rest from a labour to which it is no longer equal, when the powers of life are nearly exhausted by some lingering disorder.

It is conceived that all the other animal functions must participate in the relief thus afforded to so important an organ; and it is remarked, that even the powers of the mind itself, though most remote from our conception of material agents, are, in many persons, thus immediately affected, by the consequences of a merely mechanical operation.

*The* Bakerian *Lecture for* 1809. *On some new Electrochemical Researches, on various Objects, particularly the metallic Bodies, from the Alkalies, and Earths, and on some Combinations of Hydrogen. By* Humphry Davy, *Esq., Sec. R.S. F.R.S.E. M.R.I.A.* Read November 16, 1809. [*Phil. Trans.* 1810, *p.* 16.]

Mr. Davy having from the commencement of his electro-chemical researches, communicated the several steps of his progress to the Society, takes the present opportunity of reporting the results of his further inquiries under four principal heads. First, on the nature of the metals of the fixed alkalies. Second, on the nature of hydrogen and composition of ammonia. Thirdly, on the metals of the earths; and, Fourthly, he makes a comparison between the antiphlogistic doctrine, and a modified phlogistic hypothesis.

When Mr. Davy first communicated to us his discoveries of potassium and sodium, he adopted, as most probable, the antiphlogistic interpretation of the phenomena, and considered potassium and sodium as simple metallic bodies, of which potash and soda are the oxides. The same experiments have since been repeated by others with the same results, but the explanations given by different chemists have been various. The theory which has appeared most deserving the author's notice, and is more particularly controverted, is that of Messrs. Gay-Lussac and Thenard, who conceive these metals to be compounds of their respective alkalies with hydrogen; although in the interpretation of their own production of a metallic substance from boracic acid, they relapse again into the antiphlogistic doctrine, and suppose themselves to have effected a decomposition, by abstraction of oxygen from it.

Since the principal experiment on which Messrs. Gay-Lussac and Thenard rely, is that in which ammonia is acted upon by potash, Mr. Davy details a great number of modes in which he has varied the experiment with the utmost care to avoid moisture, which appears to

have misled the French chemists, and with the most scrupulous attention to the products.

When the experiment is conducted in tubes of iron, there is always a conversion of a portion of potassium into potash, a loss of nitrogen, and a production of hydrogen; but when platina or copper tubes are employed, the quantity of potassium remains the same, there is no loss of nitrogen, but there is a loss greater or less of hydrogen. The explanation suggested for this difference is, that an affinity of these metals for potassium may prevent its attracting oxygen from the ammonia.

For the decomposition of ammonia, sodium seems preferable to potassium, on account of the greater facility of employing it free from moisture; as the latter oxidates more rapidly at the surface, while transferring from one vessel to another, and more rapidly attracts moisture when oxidated.

Mr. Ritter founds the same opinion, that hydrogen is a constituent part of potassium and sodium, upon a singular circumstance that he has observed respecting tellurium; for he finds that this is the only metal by which potassium cannot be procured, when it is used as the conductor of voltaic electricity; and he ascribes the difference to the affinity of tellurium for hydrogen being stronger than that of potash.

From many experiments which Mr. Davy has made upon tellurium, and upon its alloys with potassium, he finds that tellurium unites with hydrogen as a solid hydruret of tellurium;—that it unites with a larger proportion of hydrogen as telluretted hydrogen, (a gas very analogous to sulphuretted hydrogen); that this gas combines with potash, forming a compound, corresponding to hydro-sulphuret of potash, and communicating to water a deep purple or claret colour.

After having thus ascertained the properties of tellurium, he found that when potash is acted upon by a very powerful battery, by means of a surface of tellurium at the negative pole, an alloy of tellurium and potassium is formed, which has the colour of nickel; when this alloy is thrown into water, the hydrogen, which in other instances is given off with effervescence, is not, in this case, extricated, but uniting with the tellurium, forms a hydro-telluret of potash, which communicates its purple colour to the water.

When a fusible alloy of potassium and tellurium was heated in ammoniacal gas, the permanent elastic fluid generated was nitrogen, not hydrogen, as is the case when potassium is employed alone; and this is considered by Mr. Davy as a proof, that in each instance the gas is derived from the ammonia and not from the metal, as the French chemists have supposed.

If the metals of potash and soda contained hydrogen, then water should be formed when they are burned. But when potassium is burned in close vessels in dry oxygen gas, or when sodium has been burned even in the open air, they do not yield hydrogen by being heated with filings of iron or of zinc, and they give no other indication of the presence of moisture.

But in order to compare potassium with its corresponding quantity

of potash in such state, as is allowed to be perfectly dry, according to the latest experiments of the most celebrated chemists, Mr. Davy converted eight grains of potassium into muriate of potash, by burning it in muriatic acid gas. Now, according to the experiments of Berthollet, recently published, eight grains of potash would make just twelve grains of muriate of potash, by the addition of four grains of acid. But the eight grains of potassium received an increase of six grains and a half, making fourteen grains and a half of dry muriate of potash, of which $4\frac{6}{10}$ths must be acid, according to Berthollet's estimation, and consequently there are $1\frac{9}{10}$ths of oxygen added to the potassium instead of hydrogen being extricated from it.

The endeavours of the author were next directed to obtaining more direct evidence of the composition or decomposition of nitrogen than he had hitherto done; and though his results have been mostly negative, he details a number of laborious and minute experiments, which he conceives may be of importance in settling various questions of doctrine that have been agitated.

Since nitrogen has been supposed to be produced during the decomposition of water by electricity, Mr. Davy has repeated that experiment by means of the powerful battery of the Royal Institution, kept in continual action for nearly two months, the product of gas being exploded about 340 times during the experiment; but the total quantity of permanent gas which remained, was not quite one quarter of a cubic inch, and this residuum was hydrogen, which may easily be referred to a slight oxidation of the wires of communication.

Other attempts were also made to form nitrogen or nitric acid from pure water, but all were unsuccessful. Wires of platina were fused by voltaic electricity in oxygen gas, saturated with moisture; with the hope, that at so high a temperature the water might combine with more oxygen; but this did not occur.

The vapour of water was passed over red-hot manganese, but no acid could thus be obtained, except by employing an unglazed porcelain tube, which was permeable to atmospheric air.

Since the formation of ammonia from pyrophori in various substances, appeared to indicate a formation of nitrogen, many such cases were examined; but it was found that the production of ammonia always depended upon the previous absorption of nitrogen by the charcoal present in such pyrophori.

With a view to decompose nitrogen, potassium was intensely heated in that gas by voltaic electricity, but without success. Phosphuret of lime was next substituted for potassium, but the nitrogen was not decomposed. Nitrogen was next mixed with oxymuriatic acid, and passed through a red-hot tube, without effecting any decomposition.

Notwithstanding such a want of conformation by any new processes, the original grounds for supposing oxygen present in ammonia remain. The amalgam produced from ammonia, which yields ammonia again by apparent oxidation, might lead to the inference

that both hydrogen and nitrogen are oxides; but from the action of potassium on ammonia, it would rather appear that nitrogen alone is in that instance decomposed.

But there is great difficulty in reasoning upon the precise nature of this amalgam, on account of the presence of water, which it is at least extremely difficult to avoid, as the amalgam cannot be formed in dry ammoniacal gas, nor by means of any dry compound of ammonia yet tried.

The driest amalgam is that formed by an alloy in which potassium is also present. In endeavouring to distil ammonium from this compound, there is always a partial regeneration of ammonia mixed with about one third hydrogen; and if the proportion of oxygen contained in ammonia be inferred from this product, it would appear to be forty-eight per cent.,—a result which agrees with the quantity which might be presumed to exist in ammonia, from the proportion in which it unites with acids. But if the proportion of hydrogen to ammonia thus evolved be less than that of one to two, the results will not accord; and then, says Mr. Davy, it may reasonably be supposed that hydrogen and nitrogen are both oxides, either of the same metal or of different metallic bases. But if, instead of endeavouring to accommodate our general antiphlogistic notions to the peculiar facts respecting ammonia, we endeavour to frame a phlogistic hypothesis to account for them, we must then suppose nitrogen to be a simple basis, which becomes alkaline with one dose of hydrogen; and metallic, by uniting with some greater proportion of the same element.

The author next details a variety of experiments, made on several of the earths, for the purpose of decomposing them. The metals of silica, alumina, and glucine, were obtained in alloy with iron; but it appeared that these metals could not be made either in direct combination with mercury, or as a triple alloy with mercury and potassium. By passing potassium, however, through the alkaline earths, lime and magnesia, and afterwards introducing mercury, solid triple amalgams were obtained. The triple amalgam from magnesia was easily deprived of its potassium by means of water; and it then appeared as a solid white metallic mass, which by long exposure to air was covered with a crust of magnesia. This section concludes with speculations on the probable quantity of oxygen contained in the earths, founded on Mr. Dalton's law of chemical union by simple particles, which appears to Mr. Davy more near the truth than that modification of it lately observed by M. Gay-Lussac.

The concluding section of the lecture contains some theoretic considerations on the nature of hydrogen in particular, and on the whole class of simple substances in general.

The fact of hydrogen uniting with tellurium and with sulphur into compounds apparently acid, it is observed, militate strongly against its being simple; and Mr. Davy inclines to consider it an oxide, of which the base exists in the amalgam of ammonium. Ammonia will then be the deutoxide of the same base, and nitrogen the tritoxide.

The class of pure inflammables will on this antiphlogistic hypo-

thesis be all metallic; some of them being as yet known only in combination, as those of sulphur, of phosphorus, and some others.

But a phlogistic hypothesis might also be framed, so as to account for all the phenomena with equal facility; the principal argument in favour of it being derived from the easy reduction of metals in presence of hydrogen. The ultimate predominance of one or the other hypothesis must, in the author's estimation, depend upon the nature of ammonia, of which the supposed elements do not present phenomena analogous to those of other simple bodies. Sulphur, for instance, whether combined with hydrogen or with oxygen, has acid properties; but nitrogen combined with one of those bodies is an alkali, and with the other an acid; so that in nitrate of ammonia, nitrogen is neutralized by nitrogen.

Mr. Davy finally adduces some new facts which accord with Mr. Dalton's hypothesis respecting the apparent union of ultimate atoms in a given relation *by weight;* and he also mentions some new instances in conformity to the observation of M. Gay-Lussac, that the different compounds of gaseous bodies are related in simple arithmetical proportions *by measure.*

*The Case of a Man, who died in consequence of the Bite of a Rattlesnake; with an Account of the Effects produced by the Poison.* *By* Everard Home, *Esq. F.R.S.* Read December 21, 1809. [*Phil. Trans.* 1810, *p.* 75.]

Thomas Soper, 26 years of age, was bitten by a rattlesnake on the 17th of October. The snake had refused to bite a ruler with which it had been teased, but as soon as the man introduced his hand into the cage for the purpose of taking out the ruler which had dropped in by accident, the snake seized his hand, and made two bites in succession, one on the thumb, and another on the fore-finger. The first person who saw him immediately after the bite supposed him to be intoxicated, and treated him accordingly; but though it is known that he had been drinking, Mr. Home is inclined to ascribe the incoherence of his language and behaviour to the effect of the poison.

In the course of half an hour a swelling had taken place on his hand, and half way up the fore-arm, with a great deal of pain. In an hour and half it reached the elbow; in two hours it extended half way up toward the shoulder, with much pain in the axilla. The man's answers were incoherent, his skin cold, his pulse 100 in a minute, and he complained of sickness at the stomach.

In the course of eight or nine hours the pain became extremely violent, the swelling very tense, so that the arteries could not be perceived with accuracy, and no pulse could be felt in any part of it. He was seized with fits of faintness every quarter of an hour.

The following morning his pulse was extremely feeble, and 132 in a minute. The swelling had not extended beyond the shoulder to the neck, but there was a fullness of that side down to the loins, with a mottled appearance from extravasation of blood. The arm conti-