in atomic volume; and hence the spectrum of H Cl, for example consists simply of the spectrum of hydrogen combined with that of chlorine, with certain changes in the intensity of some lines.

In comparing the spectra of hydrogen and water-vapor, it was found that wave-lengths of the lines of the so-called II$^d$ or compound line-spectrum of hydrogen, which has been investigated by Hasselberg, were twice those of the corresponding lines in the water-vapor spectrum. This conclusion was arrived at by comparing with the comparatively few lines of the water-spectrum that were accessible at the time. To test the conclusion, however, a list of wave-lengths that should be in the water spectrum was drawn up and sent to Professor Liveing at Cambridge, and the wave-lengths compared with those obtained by Liveing and Dewar in their recent experiments. As the result of this comparison, the author publishes a list of nearly sixty lines between wave-length 2800 and 2450, in which to each estimated line there corresponds an observed one; the difference between the observed and calculated wave-lengths in no case amounting to more than one Angstrom unit, or 1 part in 2,500.

The author therefore concludes, on the basis of his theory, that hydrogen, in that condition in which it gives this second or compound line-spectrum, occupies twice the atomic volume which it has in water-vapor.

The primary or elementary line-spectrum of hydrogen, however, it was found might be divided into two groups of lines, in such a manner that the wave-lengths of the one group when multiplied by $\frac{19}{20}$, and of the other when multiplied by $\frac{4}{5}$, gave the wave-lengths of the corresponding lines in the $H_2O$ spectrum. Whence the author, by means of his fundamental theorem, reasons thus: hydrogen is formed of two primary elements, which may be designated $a$ and $b$, and which give rise to the two parts of the elementary hydrogen spectrum under each other's influence. Let $a$ and $b$ represent the volumes of these two substances respectively in unit-volume of hydrogen; then $a + b = 1$; and, since hydrogen occupies two-thirds the atomic volume in water-vapor that it does in the primary condition, from the fundamental theorem we have

$$\tfrac{19}{20}a + \tfrac{4}{5}b = \tfrac{2}{3}.$$

From these two equations,

$$a = \tfrac{4}{5}, \quad b = \tfrac{1}{5};$$

therefore hydrogen is a combination of the form $H = ba$, and is thus analogous to ammonium ($NH_4$), and, as Professor Grünwald asserts, will, on dissociation, expand in the ratio of 3 to 2.

The primary element $a$ must be a gas many times lighter than hydrogen. The spectra of these two elements, $a$ and $b$, in the free condition may be at once obtained from the hydrogen spectrum by the previous theorem, when it is granted that the gas, on dissociation, expands in the ratio of 3 to 2; for we have only to multiply the wave-lengths of the group $a$ in the hydrogen spectrum by $\frac{3}{2}$ to obtain those of the substance $a$ in the free condition; and in like manner the wave-lengths of the substance $b$ may be obtained from the corresponding group $b$.

Professor Grünwald has tabulated five lines in the spectrum of $a$ between wave-lengths 9842 and 5653, and about forty lines of the spectrum of $b$, and each is found to correspond with a line in the solar spectrum. He concludes, therefore, that hydrogen, in the dissociated condition, exists in the sun, and identifies one of the lines of $b$ with the so-called Helium line, 5874.9 of Angstrom's scale, while reasons are given for believing the corona line (1,474 of Kirchoff's map) is one of those in the spectrum of $a$. These two component elements of hydrogen he therefore suggests might be named 'Coronium' and 'Helium.'

From similar considerations to those employed in the case of hydrogen, oxygen, in its simplest molecular condition, is found to consist of the modified hydrogen, which gives the secondary spectrum before mentioned, with an equal volume of a substance O', with which it combines without change of volume. This O' is a combination of four parts by volume of the same element ($b$) which was found in hydrogen, with five parts of another substance (O''), which is itself composed of four parts of $b$ with five parts of an unknown primary substance $c$. The formula expressing the above is,

$$O = H' [b_4(b_4c_5)_5].$$

In a long paper published in December in the *Sitzungsberichte der Kais. Akad. der Wissenschaften* of Bohemia, Professor Grünwald has extended his work to the spectra of magnesium and carbon, employing the wave-lengths as determined by Liveing and Dewar, and Hartley and Adeney, with the result that the spectrum of magnesium may be separated into four groups. The first is due to 'Helium,' neither 'condensed nor dilated;' the second is that of the primary element $c$ in the condition in which it exists in oxygen; the third is that of $b$ in the state in which it exists in free hydrogen; while the fourth is caused by the same element $b$, but in the chemically more 'condensed' state in which it exists in water-vapor.

There are still a number of weak magnesium lines which fall naturally into these groups, but the corresponding lines to which in the hydrogen and oxygen spectra are not known to exist. Carbon has similarly been resolved into a certain compound of these elements $b$ and $c$.

These speculations will require most thorough investigation and testing before they can be accepted; but the first point to be seriously examined is the basis on which they rest. If the coincidences reported by Professor Grünwald, when examined carefully, are found sufficiently close and numerous to prove that a large group of lines in the spectrum of one substance can be obtained by simple multiplication by a constant multiplier from a corresponding group in the spectrum of another substance, and if there is any other fact, such as the regular periodic arrangement of the lines, which would seem to connect that group of lines together, then it is one of the most important facts which have yet been developed in connection with spectra. But it is necessary that the agreement should be of the same order of accuracy as the errors in the determination of wave-lengths, and there should appear some other fact connecting a group of lines together. As to the 'condensation' theory, nothing need be said until the facts are more thoroughly worked up; but the remark of its author, that the intensity of the lines due to a substance will experience great differences in intensity in different combinations, while undoubtedly true, gives great elasticity to the theory, and admits of its adaptation to so wide a range of facts as to seriously weaken the evidence advanced in its favor.

## HEALTH MATTERS.

### Diphtheria in New York.

THE prevalence of diphtheria in New York and Brooklyn has awakened a renewed interest in the means for its prevention. A paper on this subject was recently read by Dr. A. Caillé before the New York Academy of Medicine, and is reported in the *New York Medical Journal*. It had been his experience, as it probably had that of many other physicians, that in certain families one or more members regularly had diphtheria in the spring or autumn. This was particularly true of children. It had occurred to him that such persons might harbor the microbes, or other essentials to the development of the disease, in the nasal and oral cavities. The germs of diphtheria would readily take hold of damaged mucous membrane.

In trying to establish the correctness or fallacy of this view of self-infection, he had selected eight cases, in all of which the patients had suffered from true diphtheria twice or more prior to October, 1885. The families were well known to him, and they had occupied the same houses or had the same surroundings for a number of years. The parents of the children were intelligent enough to carry out his instructions. All carious teeth were to be filled or extracted, the teeth to be examined from time to time; the mouth was to be thoroughly rinsed three times a day, after each meal, with either a three-per-cent solution of chlorate of potassium in water, a five-per-cent solution of *liquor sodæ chloratæ*, or a saturated solution of borax in water. Besides using it as a mouth wash and gargle, some of the solution was to be drawn into the nose. From October, 1885, to December, 1887, not one of the persons experimented upon suffered from diphtheria, although five of them had several attacks of acute pharyngitis and amygdalitis. There was diphtheria in the family of three of the number, but they did not contract the disease. While these cases were insufficient to furnish absolute proof of the benefit of such prophylactic measures, yet they went far to establish the belief, that, if the nasal and oral

cavities were kept clean by a mild antiseptic solution, the frequency of diphtheritic inflammation would be decidedly reduced.

In the discussion which followed, Dr. A. Jacobi, president of the academy, said that he believed it to be true that the diphtheritic poison could remain in the mucous membrane, and particularly in the neighboring lymphatic glands. Persons with a healthy mouth and pharynx were less easily infected than those who had catarrh of any form. The slightest scratch might give rise to erysipelas, and the same was true of diphtheria. One point in the prevention of diphtheria was of great importance: everybody had seen cases in which the patient was apparently about getting well, but suddenly had a new attack; and the attacks might thus be renewed four or five times. This was due to infection from the curtains or other things in the room occupied by the sick. In these cases prevention of renewed attacks was possible. If there were only two rooms, the child should be transferred from the one to the other at intervals of a few days, and the vacant room cleansed and thoroughly ventilated, and, if possible, disinfected. Dr. Holt believed that enlarged tonsils favored the development, and made the attack more severe.

DIPHTHERIA CARRIED BY TURKEYS. — Dr. Paulinis, in the *Bulletin Médical*, reports a most interesting epidemic of diphtheria which occurred in Skiatos, one of the Grecian isles, in the year 1884. The population of this island at the time was about four thousand. Dr. Bild, an old practitioner, is the authority for the statement that for thirty years no case of diphtheria had been known on the island. In June a child aged twelve years was attacked with diphtheria, and died. Seven other cases occurred in the immediate neighborhood: five of these died. The disease extended, until, within a period of five months, one hundred persons were attacked, of which number thirty-six died. Three weeks before the sickness of the first child, a flock of turkeys arrived from Salonica. Two of these were sick on arrival, and each of the others was subsequently attacked. Dr. Paulinis found in the throats of the sick ones patches of false membrane. The glands of the neck were swollen, and in one bird the disease had extended to the larynx, making it hoarse. One of the turkeys, after recovery, had paralysis of the legs, and was unable to walk. Although there had been no immediate contact between the sick birds and the first child attacked, still the distance between them was slight, and a wind had been for some time blowing in a direction favorable to the transportation of the disease. Dr. Paulinis believed that the disease was contracted from the turkeys, its germs being carried by the currents of air.

LEAD IN WATER. — From a report on the recent progress in public hygiene by Dr. Samuel W. Abbott to the *Boston Medical and Surgical Journal*, we abstract the following: In Sheffield, England, cases of lead-poisoning have been very frequent; during the past winter there has been an alarming increase, the number amounting to several hundred. On inquiry, it was found that these were quite exclusively among the population supplied from the high-service reservoir, in the water of which lead was found in quantity varying from half a grain to one and a quarter grains per gallon. This water was found to be distinctly acid, claimed to be of vegetable origin, arising from the peat upon the moors. To neutralize this acid, and thus prevent its dissolving the lead in the pipes, blocks of limestone have been placed in the conduit by the water company. The public analyst does not approve of this, saying that too much limestone will injure the water, and render it as liable to act on lead as if it had not been thus treated. He advises that the lime be introduced regularly and constantly in powder, or as milk of lime. Charcoal filters have been efficacious in removing the lead, in consequence of the phosphates contained in the animal charcoal used, forming an insoluble phosphate of lead.

PURE WATER FOR VIENNA. — Since the introduction into Vienna of a pure water-supply, the mortality from typhoid-fever has been greatly reduced, as well as that from other diseases. Since 1880 there has not been a death from dysentery in the city. Up to 1861 there were ten thousand wells in use in the city, and also public and private aqueducts bringing water from the Danube Canal. Although it is not so stated, we infer that these all have been abandoned. As a result of this improvement in the public health of Vienna, it would appear that water is the principal agent in the transmission of typhoid-fever, and that, in order to cause this disease almost entirely to disappear from a large city where it is endemic, it is only necessary to furnish to the inhabitants water of unquestionable purity, and in sufficient quantity.

DISINFECTION OF LIBRARY BOOKS. — The danger of infection from the use of books from circulating libraries has received intelligent attention in England, and means have been devised for their disinfection. The principal on which disinfection is based is the vaporization of carbolic acid by heat, whereby it is claimed that its action is more potent. Heat is applied to the outer casing of an apparatus, which is fully under control, so that a temperature which might injure the books can be avoided. The heat employed is from 150° to 200° F., the books being subjected to this temperature for fifteen minutes, and not injured by the process. The apparatus is said to be patented.

MORPHINE HABIT IN PARIS. — It is said that in Paris thousands of women are cutting short their careers by the use of morphine. Morphine disks are dissolved in a small bottle of water, and this is placed in a case which includes a tiny syringe. The whole apparatus is of a miniature description, and can be conveniently carried inside the smallest muff. The vice has become so fashionable that women actually fill their syringes before starting for the theatre, and thus have the means at their disposal, any moment, of injecting themselves with the drug while lounging in the *fauteuils* or in their boxes.

PASTEUR. — Pasteur and his treatment of hydrophobia — two topics which occupied the attention of the scientific world for so long a time — have hardly received even a mention of late either in the medical or the popular journals. Two of the patients treated by Pasteur for rabies have died during the present year. One of these was a boy, aged four, who was bitten by a mad dog on Dec. 6 last, and was under treatment at Pasteur's Institute from the 12th of December, 1887, until the 7th of January this year. He died of hydrophobia on Jan. 22. The second case was that of a woman, aged fifty-two. She was bitten on Jan. 23 of the present year, and was placed under Pasteur's treatment on Jan. 29. She died on Feb. 17 of hydrophobia.

ILLUMINATING-GAS. — A remonstrance largely signed by the physicians of Massachusetts has been presented to the Legislature of that State against the passage of any law allowing the manufacture of illuminating-gas containing more than ten per cent of carbonic oxide, as the intensely poisonous properties of that element of gas are well known, and are dangerous to health and life.

TYPHOID VACCINATION. — Chantemesse and Vidal communicated to the Société de Biologie some interesting observations on vaccination against typhoid-fever, claiming that in mice inoculated with cultures of typhoid bacilli a disease is produced with lesions the same as in human typhoid-fever. Mice inoculated with bouillon in which colonies have lived, but which no longer contain the bacilli, resist subsequent inoculation with the most intense typhoid virus.

## ELECTRICAL SCIENCE.

### Central Station Lighting.

ONE of the most interesting and important contributions to the question of alternating *versus* continuous currents for electrical distribution is the paper of Mr. Crompton, read before the English Society of Telegraph Engineers and Electricians. Mr. Crompton takes up the questions of expense of installation and of working, for two stations; one using alternating currents, the other using continuous currents and storage-batteries. The estimate for installation differs slightly from that given in a previous paper by the same author, an abstract of which was given in this journal, and enters much more into detail.

Mr. Crompton considers the cost for 10,000 lamps, to be supplied at one time from the central station. For the batteries the plan he advocates is the establishment of sub-stations where the storage-cells are to be placed. The lamp-circuits are permanently con-