

number of admirable drawings thrown on the screen by the large lantern of the physical lecture room. Some of the views of early apparatus were not only interesting, but valuable for their historical value. The speaker throughout carried his audience with him, as his manner was easy and withal intensely interesting. As he described the steps leading up to the invention of the photophone, he held the attention of his hearers transfixed with the same expectancy that the good reader awaits the *denouement* of the plot. On arriving at the lecture room, he may well have expressed surprise, by his introduction: "I scarcely thought in getting in, that I should be able to hear my own lecture;" for never before, indeed, has such a dense mass of humanity collected in that hall. His audience were agreeably surprised to find a man of so modest mien, when he has the distinction of having such exalted honors.

THE CONDUCTION OF ELECTRICITY BY GASES AT HIGH TEMPERATURES.

M. R. BLONDIOT has presented to the *Académie* a memoir entitled "Recherches upon the Transmission of Electricity of Low Tension by Hot Air," of which the following is an abstract: In the year 1853, M. E. Becquerel discovered that a gas at a high temperature became a conductor of electricity, and stated that the phenomenon could be observed even with a single cell. Some doubt has been thrown in later years upon the accuracy of the statement, but it has been fully confirmed by the experiments which are about to be described. The apparatus employed consisted of a sort of double bell jar placed with its mouth downward; between the outer and the inner lining a stream of coal gas was caused to ascend, and being mixed with air in its passage a powerful flame could be produced around the inner lining, which soon raised it to a state of incandescence. Within this heated jar, but entirely free from contact with any part, were placed two platinum disks, about 3 cm. in diameter. These served as electrodes. By means of this arrangement the air could be raised to a very high temperature, while currents of convection were as far as possible avoided.

In accordance with M. Becquerel's announcement, it was found that in this case no current would pass until a red heat had been attained. On the other hand, when a column of air is allowed to rise by convection from a heated body, a current may be obtained with a single element when a thermometer indicates a temperature of only 70° C. The explanation suggested is that the convection current contains many particles which are themselves far hotter than the mean temperature of the air, as shown by the thermometer, and it is these hotter particles which are alone concerned in conducting the current.

In the present apparatus, as soon as a red heat had been attained, an E.M.F. not exceeding one-thousandth of a volt produced a measurable current. It was, however, discovered that this current does not obey the law of Ohm, as on increasing the E.M.F. the current increases more rapidly than the difference of potential. This result, which has been well established, appears to be one of considerable importance as throwing light on the differences between the conduction of electricity in solids, liquids, and gases. It follows that gases, properly speaking, have no specific resistance, as the quantity so measured will depend upon the E.M.F. employed in the experiment. It is probable that the explanation of the phenomenon is to be found in the conduction by convection currents already alluded to. When the air is at the normal temperature, it is known that all bodies are coated with a kind of atmospheric film, which therefore serves as an effective insulator. But when the temperature is sufficiently raised, this film is driven off, and the gaseous molecules then come into sufficiently close contact with the surface of the metal to carry off a charge of electricity.

ELECTROLYSIS OF COPPER AND ZINC.

By ALEXANDER SHAND.

THE separation of copper from zinc or any other metal is much more easily and quickly conducted by electrolytic deposition than by the ordinary wet process. As the result of some experiments recently conducted, I have found that the electrolytic method is also much more accurate. In order to determine the accuracy of the process, 0.5033 gramme of pure copper and 0.5031 gramme of pure zinc were dissolved in a little dilute sulphuric acid, and the solution made up to 1000.5 grammes with distilled water at 15° C.

Of this solution, 100 grammes, calculated to contain 0.50304 gramme of copper and 0.5028 gramme of zinc, were weighed into a tared platinum basin, and the current from one Bunsen cell passed through the solution, the positive electrode being a platinum disk. The Bunsen cell exposed 140 sq. in. of zinc to dilute sulphuric acid, specific gravity 1.12 at 15° C. The current was allowed to continue all night, the total time being about eighteen hours.

The solution in the basin was now poured into a beaker, and the deposited copper washed three times with distilled water, then three times with alcohol, and finally three times with ether. It was then dried in an air bath at 80° C., allowed to cool in a desiccator, and weighed.

RESULTS OF TWO ESTIMATIONS.

1st	0.0504	Theory requires	0.0503
2d	0.0503	"	0.0503

A large number of experiments showed that the most accurate results, in zinc estimations, are obtained by the following process. The zinc, being in the form of sulphate, is nearly neutralized, if necessary, with potassic hydrate, free from aluminum; then add ammonium oxalate in excess. Maintain the solution at a temperature of 80° C. or 90° C. by heating with a steam or water bath, and pass the current from two Bunsen cells similar to the one used for the copper estimation. In a few hours the whole of the zinc is deposited as a pale bluish-white coating on the basin; which is washed with water, alcohol, and ether, as in the case of copper, and then dried and weighed.

RESULTS OF TWO ESTIMATIONS.

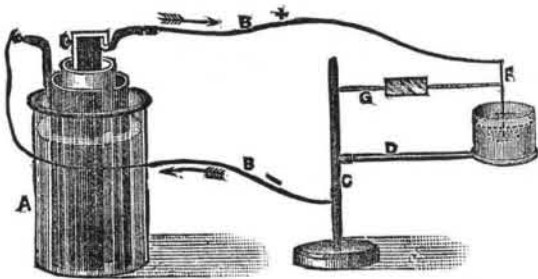
1st	22.19	per cent.
2d	22.09	"

There are a number of practical details and precautions, most of which will occur to any who may be disposed to investigate this process. It is absolutely necessary that the analysis be carried out exactly as described above, and that the platinum basin be chemically clean. If the basin is heated directly with a flame during the process, the zinc is deposited in a black powdery condition, and gives too high results. Should the acid in the battery be too dilute, the zinc comes down in a crystalline state. In this condition it is very difficult to wash without loss, as some of the crystals become detached and are easily washed away. From 0.4 to 0.9 gramme of the metal is the most convenient quantity to work with, as too large a quantity takes much longer to deposit; 1.5 gramme of copper, for instance, takes thirty hours to completely deposit with the current from a single Bunsen cell.

The accompanying wood cut will show a suitable arrangement of the apparatus for conducting the process.

ARRANGEMENT OF APPARATUS FOR ELECTROLYSIS.

A is a Bunsen cell with zinc carbon couple. B B are the conducting wires, and the direction of the current is indicated by the arrows. C is a metallic rod fixed in



a circular base; an ordinary retort stand does very well. D is a copper rod having a ring at the end on which the platinum basin, E, is supported. F is a platinum wire supported by the rod, G, and insulated by a piece of glass in the center of the rod. At the lower end of the platinum wire, F, is a small platinum disk which dips under the surface of the solution in E, containing the metal to be deposited. The other end of F is attached to the positive conducting wire, and the arrangement is complete.—*Pharmaceutical Journal*.

LIFE ENERGY, OR THE DYNAMICS OF HEALTH AND DISEASE.

By NATHL. ALCOCK.

SINCE it is admitted that matter is indestructible, it is obvious that life can be only the manifestation of that energy which is set free by the reduction of compounds embodying more energy to states of combination which embody less energy.

Life therefore is the result of the continuous interchange of partners between the compound molecules constituting chemical and organic compounds.

"In any transformation which takes place without the application, or the giving out, of work, the heat developed is the equivalent of the excess of the original over the final potential energy due to the chemical affinities involved. The final state of every combination is that in which the potential energy of chemical affinity is a minimum." (Tait.)

If these words formulate the law which governs those combinations of elementary substances known as inorganic compounds, how much more must they refer to the combinations of the same elementary substances which go to form organic compounds?

Life thus becomes an expression for the sum of the difference between the original potential energy of the food and the final potential energy of the excretions. All change in the configuration of matter, whether physical or chemical, must be accompanied by either the evolution of, or the absorption of, energy.

Energy, as far as is known, has but one source, the sun.

Whether that energy act by direct impingement of solar rays producing the ascending scale of effects from genial warmth to fatal sunstroke, or whether it be second hand, from the decomposition of vegetable matter, or third hand, from the decomposition of animal substances which obtained it from vegetable substances, its origin is still the same.

Assuming then the universality of this energy, which shows itself in all the intangible forms of life, and growth, and all organic change, it will be the effort of the writer to adduce evidence to prove that much which is still mysterious in both health and disease is due to its subtle action too.

The vibrations of direct solar energy which fall upon the optic nerve give rise to those molecular disturbances which produce the subjective sensation of light.

Physical change is thus originated by an immaterial agent. Work is done, and cannot continue to be performed without renewal of the material acted on.

But when the vibrations of direct solar energy fall upon the tissues of a growing plant, energy is incorporated into those tissues. This energy so attunes the atomic vibrations in the plant molecules as to bring them into combining harmony with the carbon and hydrogen atoms present in the forms of carbonic acid and water.

The hydrocarbon compound starch is formed, and embodies within itself the energy which made it starch.

Each molecule of starch maintains its individuality as starch only so long as it retains within itself that solar energy under the influence of which it became starch. As soon as part of that energy is lost, the starch is degraded to its original condition of carbonic acid and water. Yet that energy which works such molecular miracles is sought for among the products of decomposition in the form of heat only, and if not recognizable as such is put out of count in the world's work.

While it is thus evident that the vegetable kingdom lives a constructive life, storing up energy from an extra-terrestrial source, it is equally demonstrable that the animal kingdom lives a destructive life, unable to

add aught to the sum of energy required for the work of the planet. Consequently an approximate expression for the value of the energy incorporated in the plant may be found in the work done, as a result of its consumption, by the animal.

4,500 grains of plant carbon are daily excreted by every average man in the form of carbonic acid. Carbon and oxygen independently embody a greater sum of original energy than is found in the compound formed by their union. Therefore the result of their combining together must be a loss of energy. The value of this energy is estimated by the heat evolved. The heat recognizable on the combination of 4,500 grains of carbon with the required equivalent of oxygen amounts to 118 units, and represents in foot pounds the raising of 40 tons one foot high.

Such, then, is the enormous supply of solar energy obtained by a man when he compels the elementary atoms of carbon and oxygen to enter into a combination of greater stability and less energy, and to surrender their surplus energy that he may live.

But the converse of this is also true, viz., that when a plant proceeds to utilize this carbonic acid for the reproduction of 4,500 grains of carbon, it can do so only by obtaining from some external source energy equivalent to the raising of 40 tons one foot high and adding this to the rates of vibration already existing in the carbonic acid. Thus the condition of energy of the carbonic acid is altered till finally the oxygen and carbon atoms are compelled to dissociate themselves and to resume their elementary forms of less stability and greater energy. They then become available for plant assimilation, and fix in its tissues the energy which forced them apart.

If, then, the union of oxygen and carbon in the human body sacrifices such energy that man can live thereby, is it not obvious that under whatever circumstances that union takes place, the same energy must appear? If that be so, the question must arise whether in estimating the effect of vegetable decomposition upon the health of man, too much notice has not heretofore been taken of the carbonic acid and kindred stable products given out, and too little attention paid to the energy evolved. In fact, whether from the surface of every seething swamp there be not poured forth streams of that powerful energy which originally fed the growing plants, and which when eliminated within the body of man is known by the name of life. To assume that such energy is powerless is to assert that the mother's heat is not the force that hatches out the egg.

That the theory which attributed all noxious influence to the gaseous resultants of decomposition did not satisfy the requirements of science is shown by the greedy acceptance of the germ theory which now prevails. But this, after all, is but coming one step nearer to the action of that universal energy which is the inseparable concomitant of all material interchange. For has not Dr. Burdon Sanderson well said, "Bacterial life is a middle term between chemical antecedents and consequents"? They reduce all unstable compounds in the world to final stable products, and live with vigor or in apathy in proportion to the effect upon themselves of the energy evolved from the medium they destroy. Thus, too, is produced much of that form of secondary energy recognized as heat of decomposition; and while this heat is known to possess marvelous influence over vegetable germination, it has up to the present been credited with but little action on the life of man.

The gaseous consequents and the bacterial agents have borne the blame of every human ill, while that energy which ruled the universe before the first vegetable cell had varied toward animal functions is allowed to go unchallenged.

If, then, suspicion can be legitimately directed toward this heat as a factor in physiological change hitherto overlooked, it becomes necessary to pursue the subject of heat in all its latest developments.

Dr. Doherty, in his "Organic Philosophy," says: "Light is nothing but the velocity of a force which in slow motion is called heat." From the facts that are known in relation to light it may be possible to deduce by analogy much that is yet unproved with regard to heat.

It has been shown that light consists of certain colors which, when taken together, produce the sensation of light. Each of these colors acts upon certain specialized molecules of the optic nerve, and not upon the remainder, just as Professor Tyndall has shown that the invisible heat rays, "powerful as they are, and sufficient to fuse many metals, can be permitted to enter the eye and to break upon the retina without producing the least luminous impression."

May it not therefore be inferred that heat consists of a series of velocities of force which when taken together produce the sensation of heat, yet each of which is capable of acting upon certain specialized molecules of the nerves of sensation, while being unperceived by the remainder?

Light has been proved by Captain Abney to be the visible velocities of wave lengths from 38,000 to the inch to 60,000, and within this range from 38,000 to 60,000 to the inch all the varied sensations of color are produced. Nevertheless, by the higher velocities, from 60,000 to 120,000 wave lengths to the inch, the great chemical actions of the world are performed. Is it not evident, then, that if the recognition of wave lengths from 38,000 to the inch and upward depended solely upon the subjective sensation of light, all appreciation of them must cease at the 60,000 wave lengths, and that the great powers of the ultra-violet wave lengths must have remained in darkness for ever?

But Captain Abney has also shown that there are measurable wave lengths extending downward from 38,000 to 10,000 to the inch; if, therefore, these are credited with such action only as is recognizable by the subjective sensation of heat, is it not equally possible that the powerful influences which change for good or ill the configuration of the molecules of the nerves of sensation may be left unregistered?

It is therefore allowable to infer from this analogy that in the dark region descending from the fading red to the cold of zero there may be many rates of velocity, some of which, harmonizing with some phase of life, produce the most potent physiological effects without at the same time exciting the molecular resistance which corresponds to the sensation of heat.

In other words, is it not probable that in estimating the actions of the forces of nature upon the animal sys-