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THE DISCOVERY OF ARGON.

Some six years ago the Right Hon. Lord Rayleigh undertook one of the most difficult of chemico-physical measurements, namely, the determination of the densities of certain "permanent" gases. He established satisfactorily the densities of oxygen and hydrogen, but on undertaking that of nitrogen he was confronted with an anomaly, both curious and serious, which for some time he regarded only with "disgust and impatience."

Nitrogen to be weighed may be obtained from two entirely different sources—from the atmosphere, where it exists free, or from chemical compounds, such as ammonium nitrate, or nitric acid, in which it exists in combination with other substances. The air, as everybody knows, consists chiefly of nitrogen, oxygen, carbon dioxide, and water vapor. In order to free nitrogen from the other constituents, air was bubbled, first through a solution of potash, which detains the carbon dioxide, then through concentrated sulphuric acid, which is a trap for water vapor, and lastly over red hot copper, which is a famous oxygen "grabber," after which the nitrogen emerged into the globe prepared for it, supposably pure. Red hot iron filings, or ferrous hydrate, may be substituted for hot copper; but whatever means were employed to separate the atmospheric nitrogen from its fellow constituents, Rayleigh found that the weight of nitrogen going into the globe, in each experiment, remained fairly and satisfactorily constant.

So far, so good; but when nitrogen from ammonium nitrate, nitric oxide, or any other compound, was conducted into the glass globe, it weighed eleven milligrammes less than when it contained atmospheric nitrogen. Eleven milligrammes is not a great weight, about that of a pin's head, but it was quite sufficient to disturb the equilibrium of both his lordship's balances and—mind. It was not, however, until a year ago, after two years' work, that the result stood sharply and unmistakably out that "chemical" and "atmospheric" nitrogen differed in weight.

Now, admitting this difference to be established, an obvious explanation would be the presence of some impurity in the gas from either source. An elaborate investigation proved, so far as chemical science can prove, that the nitrogen derived from chemical sources contained nothing which could account for the discrepancy, and Rayleigh was thus obliged to ask himself the further question, "What evidence have we that atmospheric nitrogen is one substance, pur et simple?" On referring back, great was his surprise to find that the question had been put, just as sharply and decisively, one hundred years ago, by that shrewd Scotchman, Henry Cavendish, who so advanced the science of his time; and furthermore, that no work had been done since. Cavendish not only asked the question, but endeavored to answer it by the following experiment:

A mixture of air and oxygen, together with a small piece of potash, was passed into a U tube inverted over mercury. Through the air so inclosed, a series of electric sparks passed continuously for days, and even weeks. Under these circumstances nitrogen unites with oxygen to form nitrous acid, which is converted by the potash into solid potassium nitrite. The mercury rises in the tube to take the place of the disappearing oxygen and nitrogen; but Cavendish found that, even after weeks of continuous sparking, a small bubble of gas remained unabsorbed. That bubble, if Cavendish had only known it, was argon. Needless to say Rayleigh repeated the experiment. He then transferred the gas so obtained to a vacuum tube, and observed the spectrum. It was different from anything else in the universe; and lo, argon was discovered!

Cavendish cannot be awarded the honor of the discovery, because with his crude apparatus he could not feel certain that his residual bubble was genuine.

He merely concludes that "if there is any part of the phlogisticated air (nitrogen) of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude that it is not more than $\frac{1}{120}$ of the whole."

In the method of Cavendish, as improved by Rayleigh, the mixed gases, air and oxygen, are fed into an immense glass flask half filled with caustic potash. Instead of the small electric spark he uses an electric arc (from a current potential of 2,400 volts), between thick platinum terminals, situated about half an inch above the alkali. The mixed gases are absorbed at the rate of seven quarts an hour. The argon gradually accumulates, and when it is desired to stop operations, oxygen only is fed into the flask. At the end, when the nitrogen is completely absorbed, the flame suddenly changes to a bright blue color. The excess of oxygen is then absorbed by potassium pyrogallate, so well known in photography, and the argon remains free from impurity.

Soon after isolating argon, Rayleigh took Professor Ramsay into his confidence, who soon devised a chemical method which is equal, if not superior, to the foregoing. This method depends on the peculiar fact that nitrogen, so inert with most substances, will unite quite readily with magnesium to form a solid nitride. The apparatus consists of a closed system, containing soda, sulphuric acid, phosphorous pentoxide, red-hot copper and red-hot magnesium, through which the air wanders in a closed circuit until deprived of carbon dioxide, water, oxygen and nitrogen. The residue is pure argon. So far as the yield is concerned, the second method is preferable to the first, giving as much argon in eight hours as can be obtained in fourteen hours by the oxygen method.

Ramsay's method has lately been much improved by M. Guntz, who passes atmospheric "nitrogen" over several iron boats containing electrolytic lithium, which absorbs nitrogen completely at a low temperature and collects the argon over mercury at the exit end of the apparatus.

Still another method is to pass atmospheric "nitrogen" into a large flask in which there is an electric arc formed between magnesium terminals. The magnesium burns the nitrogen into solid magnesium nitride, and the argon remains.

Now, what is argon? It is a colorless, odorless gas, existing in the atmosphere to such an extent that, in a room containing 6,000 cubic feet, we should have about 50 cubic feet of argon.

Since we have thus a practically unlimited supply, can we put it to any economic use? Not unless we can make it enter into combination with some other element; and happily enough, in spite of its name—"lazy"—the famous French chemist, M. Berthelot, by means of the silent electric discharge, has succeeded in making it enter into a combination in which mercury, argon and condensation products of benzine are concerned. In addition, argon has lately been found with helium in combination with meteoric iron.

Should Berthelot's compound turn out sufficiently stable to be isolated, there is a probability that it may serve as a gate through which our element may enter into innumerable other combinations possessing properties which may or may not be useful to the race.

The very discovery of argon, however, stands as a warning to those who would teach us that science is bankrupt. R. K. DUNCAN.

ELECTRICAL ITEMS WORTH REMEMBERING.

Dropping a steel magnet, or vibrating it in other ways, diminishes its magnetism.

It is said that steel containing 12 per cent of manganese cannot be magnetized.

Flames and currents of very hot air are good conductors of electricity. An electrified body, placed near a flame, soon loses its charge.

In charging a secondary battery, the charging electro-motive force should not exceed the electro-motive force of the battery more than 5 per cent.

Lightning has an electro-motive force of 3,500,000 volts and a current of 14,000,000 amperes. The duration of the discharge of lightning is $\frac{1}{30000}$ of a second.

The resistance of copper rises about 0·21 per cent for each degree Fah., or about 0·38 for each degree Cent.

A lightning rod is the seat of a continuous current, so long as the earth at its base and the air at its apex are of different potentials.

The rate of transmission on Atlantic cables is eighteen words of five letters each per minute. With the "duplex" this rate of transmssion is nearly doubled.

The effect of age and of strong currents on German silver is to render it brittle. A similar change takes place in an alloy of gold and silver.

To obtain the number of turns of wire in an electro-magnet, multiply the thickness of the coils by the length, and divide by the diameter of the wire squared.

A test for the porosity of porous cells consists in filling the cell with clean water and taking the per cent of leakage. The correct amount of leakage is 15 per cent in 24 hours.

If the air had been as good a conductor of electricity as copper, says Professor Alfred Daniell, we would probably never have known anything about electricity, for our attention would never have been directed to any electrical phenomena.

A perfect vacuum is a perfect insulator. It is possible to exhaust a tube so perfectly that no electric machine can send a spark through the vacuous space, even when the space is only one centimeter.

For resistance coils, for moderately heavy currents, hoop iron, bent into zigzag shape, answers very well. One yard of hoop iron, ½ inch wide and 1-32 inch thick, measures about 1-100 of an ohm; consequently, 100 yards will be required to measure an ohm.

The voltage of a secondary battery must always be equal to or slightly in excess of the voltage of the lamp to be burned. For example, a 20 volt lamp will require 10 secondary cells, but 10 cells will supply more than 20 lamps.

Compression of air increases its dielectric strength. Cailletet found that dry air compressed to a pressure of 40 or 50 atmospheres resisted the passage through it of a spark from a powerful induction coil, while the discharge points were only 0·05 centimeter apart.

An accumulator with 17 plates, 10 by 12 inches, is reckoned, in horse power hours, equal to about one horse power hour. Taking this as a basis, it will require 6 cells for one horse power for 6 hours, or 30 cells for 5 horse power for the same length of time.

To obtain the length of wire on an electro-magnet, add the thickness of the coils to the diameter of the core outside of the insulation, multiply by 3.14, again by the length, and again by the thickness of the coils, and divide by the diameter of the wire squared.

Blotting paper, saturated with a solution of iodide potassium to which a little starch paste has been added, forms a chemical test paper for testing weak currents. When the paper (slightly damp) is placed between the terminals of a battery, a blue stain appears at the anode, or wire connected with the carbon or positive pole of the battery.

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR, LONG ISLAND, N. Y.

The visitors who find their way into the bright, airy laboratory at Cold Spring Harbor, and are shown about by Dr. Conn, the director, can hardly fail of getting a pleasant impression of the place. But the full charm and value of the work done here and the esprit de corps of instructors and students can only be realized by one who has studied here for a summer. And most fortunate of all the students who have ever attended the sessions of the school are those who have come this year, for the comforts of living have never before been so ample.

The foundation of the school was due primarily to the energy of Professor Franklin W. Hooper, secretary of the Brooklyn Institute, under the auspices of which it was established and is still maintained. Prominent on its board of managers from the first have been the Hon. Eugene G. Blackford, Mr. John D. Jones and Dr. O. L. Jones, and their generous gifts contributed largely to its original equipment.

For the first three summers the work was carried on at the Hatchery of the New York Fish Commission, but under much inconvenience; the necessarily limited number of students found lodgings where they could in the vicinity. But with a director so able and enthusiastic as Dr. H. W. Conn, of Wesleyan University, who took charge of the work the second summer, the school was bound to grow. In 1892, Mr. John D. Jones, already mentioned as among the first benefactors, was instrumental in the incorporation of an association called the Wawepax Society, and it is to this organization that the school owes its present ample quarters.

The laboratory which they built, after Dr. Conn's plans, was occupied last summer. This year they have put at the disposal of the students two comfortable buildings for dormitories. The one for ladies, which contains a dining room and reading room for the whole party, is especially pleasant. The buildings have been comfortably furnished by the Brooklyn Institute. Together with the lecture hall and Professor Conn's home, also given by the Wawepax Society, they form a picturesque group most conveniently situated with reference to each other.

Their location is delightful, for they stand on the hillside sloping to the head of Cold Spring Harbor, with wooded hills behind them and across the inlet, while in the distance stretches the Sound. New York is only thirty miles away, but the quiet of the place could hardly be more if we were in the heart of a desert.

Not only do we hear no market wagons, fog horns, trolley gongs or locomotive whistles, but not even a town clock disturbs us. The rest to tired nerves is almost equal in value to the benefit to be derived from the work; to some people it may mean quite as much.

The laboratory deserves fuller description. It is a pretty building, 72 feet long by 36 feet wide, finished exteriorly with shingles and interiorly with polished Georgia pine; a large brownstone fireplace partly fills one side of the main room. There are wide and high windows close together on every side, so that light and air are as abundant as possible.

Through the warm July days it has not been uncomfortable. Broad working tables fitted with drawers stand in range of the windows along the sides of the room in sufficient number to accommodate about forty students. There are six rooms fitted up for private laboratories for the professors and investigators.

Along the center of the main room aquaria are placed, through which fresh or sea water may be made to pass at will by turning a stopcock in the pipes above. Nothing in the life here is more entertaining than to watch that of the forms which for the time inhabit these aquaria. To-day we may find the sides of one beset by star fishes, little and big, their ambulacral feet clinging so fast that they will lose some rather than let go, if you attempt to move them. Below them hermit crabs are looking out from snail shells of varying sizes; a spider crab is dining off her own eggs, which she picks out with her long claws, while another is feasting upon a dead brother.

Scollops are popping up and down in jolly fashion, and great clumsy whelks have their broad yellow feet spread firmly upon the side of the aquarium where they are companions in exile.

In the next one, perhaps, there is a mass of squids' eggs in long, airy looking sacs, from which, one by one, minute independent squids now begin to swim into sight. Farther on we may see botanical specimens: delicate green or red algae, and beside them in the next aquarium is a pond lily plant, root, leaves and fruit all in sight. Yesterday one aquarium was full of beautiful sponges, of which several varieties are found in the Sound. To-morrow some of these forms that we have watched with so much interest will give place to others perhaps even more curious.

These specimens are, for the most part, brought in by dredging parties who go out in the naphtha launch belonging to the laboratory. It is run by a man who knows just where to "let down the net" for everything these waters yield. The boat is swift and fairly comfortable, and the excursions upon it are among the most delightful and profitable features of the life here.

The working day begins at nine o'clock in the morning, when Prof. Fernald, of the State College, Pennsylvania, gives a lecture in the course in zoology and Prof. Conn gives one to advanced students in his course in embryology. These last an hour, and then all pass to their places at the tables in the laboratory. Each student is provided with the instruments he needs for dissection, and with a microscope, if he has not brought his own. The morning is all too short for the work that is to be done—the verification of the lectures or the study of some forms kindred to those presented by the instructors.

Let us go about the room during one of these experimental hours. We may find some students watching the development of newly fertilized eggs of oysters or squids. Here a young man is working out the nervous system of a species of worm—no easy task. We notice that a group is studying the lobster. They are at various stages of progress; one lady is making careful drawings of each of the appendages, while another is already tracing the digestive tract, and a third is finding the chain of nerve ganglia and their connections. The instructors are going about from place to place, adjusting a lens for one student, directing a cross section here, advising a better mode of procedure, helping or suggesting, as the case may be, but always attentive and unflagging in interest.

Many students are taking two courses, and in the afternoon two more lectures are given; one in the course in botany, by Prof. Johnson, of Michigan University, the other by Prof. Conn, on bacteriology. The afternoon laboratory work is largely botanical. Here is an enthusiast who has scarcely been seen since the day of his arrival without a quantity of mushrooms about him; he draws them, makes water color sketches of them, dries them, labels them, calls your attention to their beauties and peculiarities—does everything but eat them. Across the room we find several students are making slides. Their skill and success is evident if they invite you to look through their microscopes, for you find they have captured sea anemones and hydroids with tentacles spread, and the delicate forms have all the interest of a living specimen, save that they are motionless.

The students may be divided into three general classes: First, investigators who are working toward Ph.D. degrees in some college or university; second, teachers of science who have come to learn better methods, to get laboratory practice and to find out the latest opinions on unsettled questions in science; for example, whether both botanists and zoologists are still claiming volvox. The third class is composed of the youngest students, who are still undergraduates in college, or are supplementing the work which they have just completed there, preparatory to teaching or other practical science work. Most of these are from Wesleyan University.

But whatever the attainments or objects of all these students, there is no discounting the zeal and enthusiasm with which they study. The generous willingness to show what they find out so characteristic of the great scientists prevails here. Not a day passes but we see as interesting objects through other microscopes as our own.

The later parts of the day are devoted more or less to bathing, boating on the harbor or one of the ponds close by, or to rambles in the tempting woods. The wheelmen are among us, of course, and come into breakfast or dinner with cyclometer records that fill us with amazement, but which they assure us are quite within the bounds of moderation. Sometimes we have an evening of college songs, jolly, rollicking and care-dispelling as nothing else can be.

Once a week an evening lecture, semi-popular in its character, is given, and to this residents and summer dwellers or visitors at Cold Spring Harbor are invited. Prof. Conn opened the course with a suggestive lecture on "Evolution." Prof. Fernald followed with a charming account of "Three Months in the Bahamas."

This week we have had an illustrated lecture on our common wild flowers by Mr. Van Brunt, of New York. The beautiful colored photographs which he shows are his own and his wife's work, and very difficult to make, he says, "because the flowers are so full of life and move so much." But they have succeeded in getting pictures as poetic as they are true.

Reference has already been made to Prof. Conn's course of lectures on bacteriology. His investigations in this field, which have put him among the foremost bacteriologists, are carried on at the laboratory during the summer. Some ninety colonies of bacteria are under examination, the preparation of their culture media, their sterilization and that of the utensils used about them, the daily record of growth, multiplication, etc.—all this work is carried on under Prof. Conn's direction by his students and assistants. In time these ninety colonies will be differentiated and their value or deleterious effects will be tested.

Besides this work, the cultivation of Prof. Conn's famous "Bacillus Number 41" is carried on here, and from here it is mailed to creameries far and near where it has been adopted. The fact is that the application of this bacillus to butter making is revolutionizing the business, for not only does its introduction into the cream give a superior flavor to the butter, but it also makes it keep better. Already, some Iowa creameries have made between $20,000 and $30,000 by its use, for the reason that whereas they were formerly not able to get their butter into the seaboard markets soon enough to command the highest price, now they do, for they can sell their product for fresh butter.

This practical outcome of investigation with the bacteria which thrive in milk can hardly fail to act as a stimulus to some students at the laboratory to persevere in their patience-taxing study, and it is not unlikely that the world may some day see important results from their work. To the students least ambitious for renown or reward of any sort there is a stimulus in the thought of Mr. Benjamin Kidd that "in our time biology has been raised from a mere record of isolated facts to a majestic story of orderly progress."

Cold Spring Harbor, L. I., July 27, 1895. A. D.

A Great Gas Holder.

The recent completion of the largest gas holder in America, in connection with the largest metal tank ever constructed, is an event in the history of the gas industry worthy of notice.

The holder in question was built by Messrs. R. D. Wood & Company, of Philadelphia, for the New York and East River Gas Company, at their works in Ravenswood, Long Island City, nearly opposite Sixty-fourth Street, New York City. It has a capacity of five million cubic feet. It is the first holder of importance built in this country with the inner lift rising above the top of the guide frame when fully inflated.

The general dimensions of the holder are as follows:

First or inner lift	179 ft. 0 in.	diameter	by 48 ft. 6 in.	deep.
Second lift	182 ft. 0 in.	"	" 49 ft. 0 in.	"
Third lift	184 ft. 6 in.	"	" 48 ft. 6 in.	"
Fourth or outer lift	187 ft. 0 in.	"	" 49 ft. 2 in.	"
Steel tank	190 ft. 0 in.	"	" 49 ft. 6 in.	"

Guide frame; 24 standards, 148 feet high; 5 tiers of latticed girders.

The tank rests upon a concrete foundation, the space under the bottom plates being filled with a cement grouting run through holes in the plates after the bottom was lowered upon the foundation.

The top of the tank shell is stiffened by a horizontal plate girder, 48 inches wide, which serves as a walk around the tank, extension plates being placed back of each standard to permit passage.

When the holder is fully inflated, the crown is over 40 feet above the top girder and is reached by means of a chain ladder kept taut by a weight on its lower end, working in guides. When the holder is filled with gas, the crown is 240 feet above the level of the ground.

The largest holder of the world is that built by Messrs. Clayton & Sons for the South Metropolitan Company, at East Greenwich, London, and which possesses the enormous capacity of 12,200,000 cubic feet. It consists of six lifts, of the following dimensions:

Inner lift	287 ft. 6 in.	by 31 ft. deep.
Second lift	290 "	" 32 " "
Third lift	292 " 6 "	" 32 " "
Fourth lift	295 "	" 31 " 6 in. deep.
Fifth lift	297 " 6 "	" 31 " 3 " "
Bottom lift	300 "	" 31 "

The depth of the masonry tank is 34 feet, 13 feet of which is below ground and 21 feet above.

Curves of Least Resistance.

A novel method of determining the curves of least resistance in water and air was recently employed at Newport News, and was described in the American Engineer of July by M. Moulton, S.B. The idea was to make the water and air themselves shape the model, and accordingly rectangular blocks of ice were towed in the water, and the alterations in their shape and in the pull necessary to keep them moving at a certain speed carefully noted. The method proved quite successful, and the experiments will be continued until complete data are obtained. Wax was the material used for the models moving in air, and the air currents were heated sufficiently to gradually melt the wax.