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The Inert Gases

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the barn, the roof of the cow-shed will serve as well; any place out of the wind will do in a pinch. He eats what he finds, abstains when he must, and voices no complaints. Food to him is food, whether in the pig-sty, in the wheat shock, or in the offal in the street.

But his strongest claim to greatness is his perseverance. Tear out his nest and he will build another in the same place, and he starts rebuilding at once without stopping to grieve over the loss. Destroy his eggs, and more will come; drive him out of the barn, and he will roost in the straw-stack; poke him from there and he will roost in the trees. He is simply bound to stay somewhere, and that somewhere is pretty likely to be on those particular premises. You can't drive him away permanently. When I was a boy, I spent half my time shooting sparrows, but I never succeeded in driving them off for more than an hour or so. There is not another bird in the world that will stand such treatment and still stay on the job.

Yet he rarely allows his perseverance to overcome his common sense. He soon learns to know a gun, and that a man with a gun and a man without one are two very different persons so far as sparrow safety is concerned. Go out to feed your hogs and Mr. Sparrow is under your feet; go out with a gun and the same individual will be entertaining his friends at a respectful distance. I am positive, also, that he watches to see when you go back into the house with the gun.

All this is not meant to imply that he has no weaknesses. You may catch him in a trap without much difficulty, but you can do so with almost any other bird. He will occasionally allow you to shoot at him a few times and maybe kill some of his fellows before becoming doubtful of your good intentions. But this is sometimes true of that wary old fox, the crow. I once killed seven out of one tree in five minutes. He may be poisoned also, but in all these ways he shows himself only to be truly bird-like, that is, relatively simple-minded when pitted against human intelligence. Yet when it comes to getting along with difficulties—I should say, in spite of them—he is far ahead of any bird I know.

It is zero out of doors as I write this, but even now, three or four of them, mere balls of ruffled, sooty, brown feathers, are sitting on the stone window sill looking in at me with bright, watchful eyes. Ishmaels they may well be, but as for me, may their numbers never grow less.

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THE INERT GASES

CHEMISTRY

A hard-headed, clear thinking, international business man has recently arrested the attention of educators by setting up an educational measuring stick. Owen D. Young, ex-teacher and industrialist, has listed the goals of American education, and places near the top the healthful stimulation of the emotions. In its application to teachers of chemistry, two opportunities open. Chronologically, they represent extremes. Pupils can be inspired by the wonderful contributions which chemical accomplishments have made to our daily lives. Teachers seldom fail in this regard. But the pupil can be equally, and more effectively, inspired by the history of chemical discoveries and the men who battled upon their frontiers. Especially is this true if such men labored and achieved within the lifetime of our own generation. Argon and helium are elements whose history is strictly modern and truly romantic.

Nitrogen gas is lazy. A chemical revolution may enlist and lead away nearly every other element and compound in the air, but nitrogen will stay at home and refuse to become excited. Less than forty years ago, Lord Rayleigh in England made use of this characteristic by removing the other components of the air and collecting the remaining supposedly pure nitrogen in order to study it. This pure nitrogen had a weight of 1.2572 grams to the liter. He also obtained pure nitrogen from pure chemicals. This sample of the gas had a weight of 1.2505 grams per liter. Strange, he thought, I must have made a mistake in purifying my gas from the air. Repeatedly he prepared nitrogen from the air and as often it gave a weight of 1.2572 grams. At his wit's end, he received the help of a renowned chemist, Professor (later Sir) William Ramsay. Ramsay knew what every high school chemistry pupil has learned: that nitrogen can be induced to wake up and join with a highly active element, such as magnesium. He reasoned that if this nitrogen of the air was mixed with another lazy and heavier substance, perhaps this "impurity" would not even be interested in magnesium. Hence Ramsay took some of Rayleigh's purified nitrogen and passed it repeatedly over hot magnesium. Greedily the two united and formed magnesium nitride. (Note: Ask your class who made the first nitride. The answer is: Paul Revere.) Yet, after every trial, a small amount of gas remained. Careful study of this residual gas revealed that it was not nitrogen, that it was, in fact, an element never before discovered. Since it took the palm for inactivity, it was named argon, from the Greek word for "lazy." It is interesting to note that Ramsay showed the gas to his class before making his discovery public, remarking that "I think that one's students deserve the first of everything."

Now let us go back in history to introduce the discovery of the second of the inert gases of the atmosphere. A total eclipse of the sun was forecast for August eighteenth, 1818, visible in India. Scientists from far and wide journeyed to India to study the manifestations in the space surrounding the sun which could be observed only when the bright orb was entirely in the moon's shadow. More important, a new instrument was to be used. Janssen, a French astronomer, was for the first time to point a spectroscope at the sun. The results were startling. In addition to two bright yellow lines called D1 and D2, which were given by the known element sodium, he saw a third yellow line. Janssen was inclined to assign this new line to sodium and he labelled it D3. He communicated his discovery of the new spectral line to Lockyer, an English scientist. A careful survey of the astronomer's observations established beyond doubt that the yellow line was due to an undiscovered element in the sun's atmosphere and to this Lockyer gave the name "helium," meaning, in Greek, "the sun."

Let us return to the 1890's and to the United States. Hillebrand, of the U. S. Geological Survey, is studying ores called the uraninites. By proper treatment of them he obtains a gas which seems to be nitrogen. He sparks it with oxygen and obtains nitric oxide; with hydrogen and ammonia results. To be sure, the action is slow and it produces a peculiar spectrum. Jokingly his assistants suggest that he has found a new element. In like humor he dismisses the possibility and so unknowingly denies himself and American science the honor of a great discovery.

Meanwhile Ramsay, elated over the discovery of argon, immediately started a search for new sources of the gas. Providentially, shall we say, he received a letter from Miers, the great mineralogist of the British Museum, who called his attention to the work of Hillebrand and suggested that he study the American's supposed nitrogen. Eagerly, Ramsay followed this lead and extracted some of the gas from cleveite. Now to study it. He writes "I bottled the new gas in a vacuum tube and arranged so that I could see its spectrum and that of argon in the same spectroscope at the same time. There is argon in the gas; but there was a magnificent yellow line, brilliantly bright, not coincident with, but very close to, the sodium line." He hastened with the news to Crookes (inventor of the Crookes tube) who had the equipment for accurately measuring spectral wave lengths. Soon came the announcement that the yellow line was identical with the D3 line of solar helium. Helium had been discovered on the earth! Ramsay's modest announcement merely stated that "Mr. Crookes has identified the yellow line with that of the solar element to which the name 'helium' has been given." Hillebrand missed this great discovery because, in his mixture of nitrogen and helium, he identified only the nitrogen.

In quick succession and within four years, Ramsay and his associates anonunced the discovery of krypton, neon, and xenon, in order.

And so the family of inert, atmospheric gases was complete.

Conceived in pure science, their value to humanity has already been demonstrated. Argon, by virtue of its inertness, is used in electric light bulbs. Because of its low solubility in the blood, helium is supplanting nitrogen in caissons, to reduce the danger of "bends" among workmen. And the great dirigible Akron with its seven and one-half million cubic feet of helium is a reminder that this gas is superior to hydrogen in its diffusion rate and incombustibility, and has 92% of its lifting power.

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TWO FUNDAMENTAL EQUATIONS OF CURRENT ELECTRICITY

Formulas in physics are mathematical expressions of natural laws or principals well established. The two most important for the ordinary citizen are first the one that gives expression to Ohm's law and second, the one that shows how to calculate the power of a current.

The mathematical expression for Ohm's law is $C = E \div R$. In this equation C stands for the current in amperes, E for the electromotive force in volts and R for the resistance of the electric circuit in ohms. Since this equation is the most basic in current electricity, it should be given special emphasis by the instructor of high school physics. The units ampere, volt and ohm should be made concrete to the student. The best way to do this is, of course, the one that is generally employed in the best texts when discussing current electricity, viz.: by bringing out the analogy that exists between an electric current and a water current.

A water current running down a river channel has three clearly defined characteristics which are easily observed. First, the stream of water in a river possesses magnitude which can be expressed arithmetically by stating that a certain number of cubic feet of water pass a given line drawn at right angles to its flow in a minute or in an hour. In other words the magnitude of a river stream is the quantity of water discharged past a given line across its bed in a given unit of time.

The second property readily observed with reference to a stream of water is manifested by its rapidity of flow. This property is clearly due to the intensity of the force operating upon the water to make it flow. As we know, this force is gravity and its intensity is directly proportional to the slope of the channel or the difference in level between two points located above and below the point of observation. If in a distance of 100 feet along the bed of the river there is a difference of 10 feet in level with reference to some plane of observation, the force of flow will be just twice as intense as that which exists when the fall in level is only 5 feet under the same conditions.

The third characteristic of water current is determined by the character of its bed or channel. If the bed of the stream is rough and rocky there is more resistance to its flow that when the bed is smooth and wide. The magnitude of the flow in a water stream is clearly dependent upon the resistance of its bed. In fact the magnitude of a flowing current of water varies roughly directly as the force operating upon it and inversely as the roughness or resistance of its bed. This, of course, does not consider the internal resistance of the water itself due to its viscosity.

The basic characteristics, current magnitude, electromotive force and resistance of an electric current are quite analogous to those of a water current. In the first place the magnitude of an electric current is the quanity of electricity discharged past a given point in its circuit in one second. This quantity is measured in terms of a unit called the coulomb. A coulomb is the quantity of electricity discharged by a current of one ampere in one second past a given point of its circuit. Since the magnitude of a current of electricity cannot be observed directly, as is the case with the water current, it must be apprehended from its effects. An ampere of current is one that can free .001118 grams of pure silver from a silver plating solution in one second. The value of an ampere can be determined from the electrolysis of any metallic salt, although it is customary to use solu-