

## IRON AND STEEL ANALYSIS.

By J. JAS. MORGAN.

THE chemicals used in the analysis of iron and steel must be pure, and in all cases the weight of the filter paper ash subtracted from the weight of the precipitates, etc. That this is necessary will be seen from the following example: The silica ( $\text{SiO}_2$ ) + ash of filter paper was found to weigh on 4 grammes of steel, 0.004 gramme, which equals 0.046 per cent. of silicon. The weight of the filter paper ash was 0.002 gramme, therefore the correct weight of the silica was 0.002 gramme, and not 0.004 gramme; which equals 0.023 per cent. of silicon. We shall give directions for the estimation of the following substances: Graphite, silicon, sulphur, manganese, phosphorus, and carbon.

**GRAPHITE AND SILICON.**—Place 4 grammes of the sample in a state of fine division in a porcelain dish of about 500 c. c. capacity, add 50 c. c. of nitro-hydrochloric acid (made by mixing one part nitric sp. gr. 1.42 with three parts hydrochloric acid), and evaporate to dryness on a hot plate or sand bath. Heat strongly until the mass becomes black, allow to cool, moisten with 50 c. c. of hydrochloric acid, and evaporate down until a crust begins to form on the top of the solution. Add the least possible quantity of hydrochloric acid sufficient to dissolve the crust, dilute with hot distilled water (when water is spoken of, *distilled water* is meant), and filter off the residue, which consists of silica and graphite, through an English filter paper, receiving the filtrate in a beaker. The residue adhering to the sides of the dish is removed by rubbing it with a piece of caoutchouc tubing attached to the end of a glass rod (called a "rubber"), rinsing it into the filter. Wash the filter and its contents; 1st, twice with a two per cent. solution of hydrochloric acid; 2d, with hot water until a drop of the washings, placed on a porcelain slab, gives no coloration with sulphocyanide of potassium. The filter and its contents are then placed in a fireclay dish, and the paper burnt off at a low heat, great care being taken not to employ too great a heat or else some of the graphite will be burnt off as well. Upon cooling, the residue, consisting of graphite and silica, is weighed, replaced in dish, and the graphite burnt off at a bright red heat, allow to cool and again weigh. The second weight (silica) subtracted from the first weight will equal the graphite on the number of grammes used.

To find percentage, multiply by 100 and divide by number of grammes taken.

Example: 4 grammes of the sample taken:  
Weight of 1st residue (graphite and silica). 0.300 grm.  
" 2d residue (silica)..... 0.200 "

Graphite on 4 grammes..... 0.100 "

Percentage equals..... Gramme.

As 4: 100:: 4) 0.100

0.025

100

2.5 = 2.50 per cent.

To find percentage of silicon, multiply the second weight by 0.466, divide by number of grammes taken, and multiply by 100. As steel contains only very minute quantities, if any, of graphite, the residue obtained upon treating the sample as described is burnt at a bright red heat and weighed as silica,  $\text{SiO}_2$ , which contains 46.67 per cent. of silicon (Si).

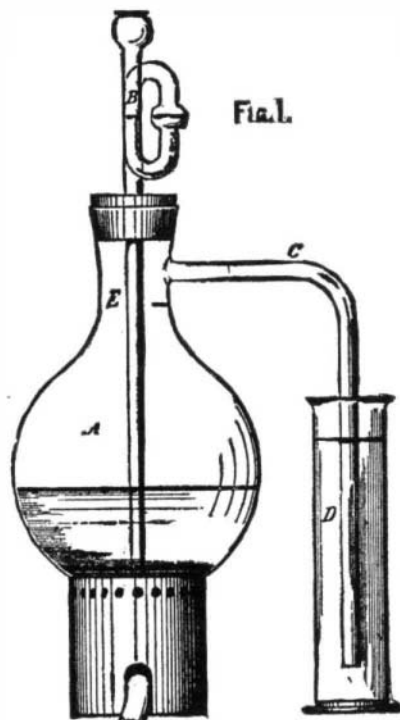
**SULPHUR.**—Is usually estimated as barium sulphate ( $\text{BaSO}_4$ ). Evaporate the filtrate from the silicon down to about 50 c. c., dilute with 700 c. c. of water, and add 5 c. c. of barium chloride solution—made by dissolving 1 part of the salt in 10 parts of water—mix; cover the mouth of the beaker with a watch glass, and allow the solution to stand in a warm place for twenty-four hours. At the end of this time filter the solution (the greater portion of which may be siphoned off, care being taken not to disturb the precipitate) through a Swedish filter paper, removing the precipitate adhering to the bottom and sides of the beaker by means of the rubber. Wash, 1st, three times with a 3 per cent. solution of hydrochloric acid; 2d, well with hot water; burn in a platinum crucible, and weigh the barium sulphate, which contains 13.73 per cent. of sulphur. A quick and fairly accurate method for the estimation of sulphur is to treat the steel or iron with dilute sulphuric acid, passing the evolved gases through a solution of copper sulphate, which precipitates the sulphur as copper sulphide,  $\text{Cu}_2\text{S}$ , which is collected, burnt into  $\text{CuO}$ , and weighed.

The process is as follows: The flask, A, which has a tube, C, bent at right angles welded to the neck, is fitted with a caoutchouc cork, through which passes the safety funnel, B, reaching nearly to the bottom of flask, and in it placed 10 grammes of the steel or iron. Fill the cylinder, D (of 200 c. c. capacity), with 160 c. c. of sulphate of copper solution, made by dissolving 50 grammes of the crystals in one liter of water, and place the flask over a Bunsen burner or spirit lamp, so that tube, C, reaches nearly to the bottom (inside) of the cylinder, D, containing the copper sulphate solution. Through funnel, B, pour upon the sample sufficient dilute sulphuric acid to cover the bottom of the flask to a depth of two inches. The evolved gases, consisting of sulphureted hydrogen, etc., pass through into the copper sulphate solution, where the sulphur of the sulphureted hydrogen combines with the copper, forming a black precipitate of copper sulphide,  $\text{Cu}_2\text{S}$ . Toward the end the action may be hastened by applying a gentle heat. When gas ceases to be evolved, pour hot water through B until mark, E, is reached; remove tube, C (by raising the flask), washing any of the precipitate adhering to it back into D with cold water. Filter contents of D, well wash with cold water, ignite at a red heat, and weigh the resulting copper oxide,  $\text{CuO}$ . To convert the  $\text{CuO}$  into sulphur, multiply by 0.7985.

**MANGANESE.**—Dissolve 2 grammes of the sample in 50 c. c. of nitro-hydrochloric acid, and upon complete solution transfer to a flask of 2 liters capacity, add 1½ liters of hot water. To this solution, ammonia is cautiously added, shaking well after each addition, until a slight permanent precipitate commences to form, and then 200 c. c. of hot ammonium acetate, the iron will be precipitated as a basic acetate of iron, boil,

and allow the precipitate to settle. Filter through a large filter, and well wash the filter and its contents. In all probability, the filtrate will not run through clear, showing that the precipitation of the iron is incomplete. This is rather to be desired than otherwise, because if all the iron has been precipitated, in all likelihood it would have carried down some of the manganese with it. Should this be the case, the filtrate is boiled and refiltered. It is then evaporated down to 500 c. c.; filtering off any precipitate which may have come down during the operation, and allowed to cool.

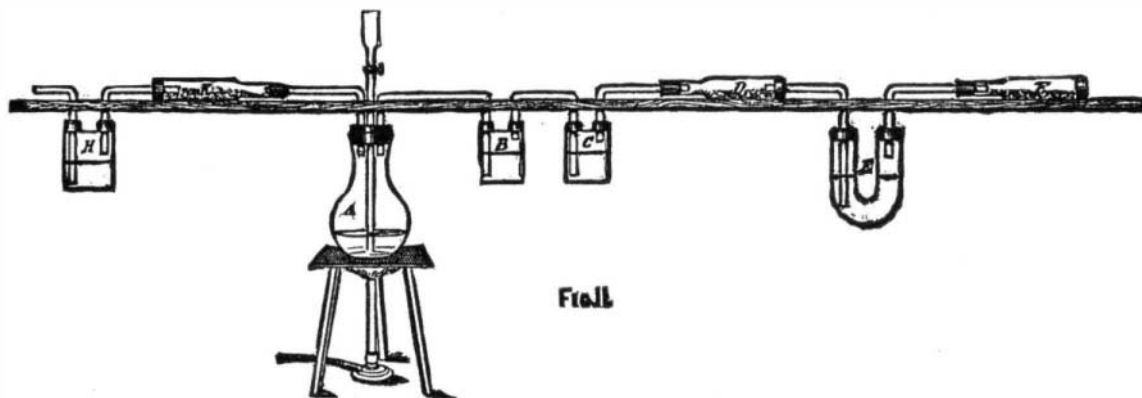
To the solution add a slight excess of ammonia, then a small quantity of bromine, and finally an excess of ammonia, agitating after the addition of each reagent. Boil and filter off the precipitated hydrated oxide of manganese, wash well with hot water, convert into trimanganic tetraoxide,  $\text{Mn}_2\text{O}_3$ , by ignition at a white heat, and weigh. The  $\text{Mn}_2\text{O}_3$  contains 72.00 per cent.



of manganese. It is advisable to test the manganese precipitate for iron, which is done by dissolving it in hydrochloric acid, withdrawing a drop on the end of a glass rod and bringing it in contact with a drop of sulphocyanide of potassium on a porcelain slab, when, if iron is present, a red coloration will be formed. If iron is detected, the remainder of the solution is diluted with about 60 c. c. of water, ammonia added until neutral, and the iron precipitated with ammonium acetate, boil, filter, burn, and weigh the ferric oxide, the weight of which is subtracted from the weight of  $\text{Mn}_2\text{O}_3$  found.

The method given below, which is a combination of the "potassium chlorate" and "bromine methods," and which the author has found to give accurate results, has several advantages over the bromine method—1st, a larger quantity of the sample may be taken; 2d, the larger bulk of iron is got rid of; 3d, the time occupied in performing the analyses is less.

The method is as follows: Weigh 4 grammes of the sample, place in a conical flask, and dissolve in 50 c. c. of nitric acid, sp. gr. 1.20. When dissolved, add 22 c. c. nitric acid (sp. gr. 1.42) and 6 grammes potassium chlorate, and boil for ten minutes. At the end of this time add 10 c. c. nitric acid (sp. gr. 1.42) and 8 grammes of potassium chlorate, and boil for fifteen minutes. Allow to cool, and dilute with cold water. Pass the supernatant solution through a Swedish filter paper, allowing the precipitate of manganese dioxide ( $\text{MnO}_2$ ) and a little iron oxide to remain in the precipitating vessel. Dissolve in hydrochloric acid any of the precipitate which may be on the filter, receiving it in the flask which contains the precipitate; add hydrochloric acid to dissolve the  $\text{MnO}_2$  precipitate; dilute;



throw down the iron with ammonia and ammonium acetate; filter; cool the filtrate; and precipitate the manganese with ammonia and bromine.

Phosphorus may be estimated either as phosphomolybdate or pyro-magnesium phosphate, but we shall only give a description of the former process. Take 4 grammes of the sample (in the case of high percentage, two or even one gramme is quite sufficient), dissolve in 50 c. c. nitro-hydrochloric acid, and evaporate down to dryness. Heat the mass until it becomes black, as in the estimation of silicon. Unless the mass is heated, all the phosphorus will not be oxidized into phosphoric acid, some of it remaining as phosphorous acid, which is not precipitated by ammonium molybdate.

When cool add 50 c. c. hydrochloric acid, evaporate down to a small bulk, dilute, and filter off the silica, etc. To the filtrate add 40 c. c. nitric acid (sp. gr. 1.42), and evaporate down until it measures 50 c. c. To this

solution add 10 c. c. nitric acid (1.42) and 50 c. c. of the ammonium molybdate solution; shake well, and allow to stand in a warm place for ten minutes. If all has gone well, the phosphorus will be precipitated as a yellow precipitate. Ascertain, as far as can be judged by smell, whether the solution is acid or ammoniacal; if strongly acid, add ammonia until it is only slightly so (it is advisable to have the solution slightly acid to prevent ammonium molybdate being precipitated); if ammoniacal, add nitric acid until slightly acid. When this point is reached, allow to stand in a warm place until the supernatant liquid is perfectly clear, filter through a weighed Swedish filter, rinsing the precipitate on the filter with a dilute solution of nitric acid (one part acid to ten water). Wash four times with the nitric acid; dry the filter paper and its contents in the water oven and weigh. The weight, minus the weight of the filter paper, equals the phosphomolybdate, which contains 1.63 per cent. of phosphorus.

**PREPARATION OF AMMONIUM MOLYBDATE SOLUTION.**—Dissolve 50 grammes of ammonium molybdate in one liter of water, and add 150 c. c. ammonia (sp. gr. 0.880). Allow the solution to stand for a few days and decant from any precipitate which may have formed.

**CARBON.**—(Colorimetric method.)—When steel or iron containing combined carbon is dissolved in nitric acid, the solution becomes of a brown color, varying in depth in proportion to the amount of carbon present. Upon this Eggertz's color test is founded. With steels that have been hardened or contain more than 0.80 per cent. of combined carbon, the method does not give reliable results. In using the method it is necessary to have a standard steel of the same make, in which the carbon has been carefully estimated by the combustion process, and containing, as near as possible, the same percentage as the sample to be tested.

**METHOD.**—In a dry test tube, ½ in. diameter and 6 in. long, place 0.2 gramme of the sample to be tested, and in a similar tube the same quantity of the standard steel; to each 5 c. c. of nitric acid (sp. gr. 1.20), free from chlorine. When all action is at an end, the tubes are placed in a beaker containing boiling water, and allowed to remain for fifteen minutes; the tubes are then withdrawn and placed in a beaker of water (cold) to cool. Into a graduated tube of 200 c. c. capacity (divided in ½ c. c.), pour the standard solution, rinsing the last portion in with the smallest quantity of water (cold) possible; dilute with water, and mix, by placing thumb on top of tube, and turning upside down.

A good plan is to dilute the standard until the number of c. c. it occupies is divisible into the percentage of carbon it contains. Thus, if the steel contains 0.14 per cent. carbon, dilute to 7 c. c.; if 0.36 per cent., to 9 c. c.; and so on. The solution of the steel to be tested is then transferred to graduated tube of the same caliber as that used for the standard, and after rinsing in the last portions mixed *without dilution*. Compare the color with that of the standard, and if darker, cautiously add cold distilled water until the tints are similar. (To compare the colors, hold the tubes side by side before a window with a piece of plain white paper behind them.) When the colors correspond, read off the numbers of c. c., which, multiplied by the quotient obtained by dividing the number of c. c. to which the standard was diluted into the per cent. of carbon it contains, will give the per cent. of carbon in the steel.

**ESTIMATION BY COMBUSTION.**—When steel or iron is placed in a solution of copper sulphate, the iron displaces the copper and enters into solution; while the copper, together with the phosphorus, com. carbon, graphite, silicon, and sulphur, is deposited. Upon treating the carbonaceous residue with sulphuric and chromic acids, carbon dioxide is formed, which may be absorbed by passing through a solution of caustic potash. This is the principle of Ullgren's method.

In a beaker containing 150 c. c. of copper sulphate solution—made by dissolving 200 grammes of sulphate of copper crystals in one liter of water—place 4 grammes of the sample, and heat gently with constant stirring. Should the solution become colorless, add more of the sulphate solution. When the iron has completely dissolved, allow the residue to settle, and pour off as much as possible of the supernatant solution. Rinse the residue, together with the remainder of the copper sulphate solution, into the flask, A, using the smallest quantity of water possible, and connect with the rest of the apparatus. Through the acid funnel add 100 c. c. strong sulphuric and 16 grammes chromic acids (dissolve 16 gr. mmes chromic acid crystals in 10 c. c. water) and

apply a gentle heat, regulating it so that a regular evolution of gas is maintained.

The gas passes through B, containing a solution of sulphate of silver in sulphuric acid, to absorb any chlorine, into C and D (which contain sulphuric acid and calcium chloride to dry the gas), and then into the U tube, E, containing caustic potash, which absorbs the carbon dioxide. When white fumes begin to appear in A, the heat is withdrawn, and a current of air drawn through the apparatus, and when cool the tube, E, is weighed. The difference in the weight before and after the experiment equals the carbon dioxide absorbed, which contains 27.27 per cent. of carbon. The tube, F, which is weighed before and after the experiment, contains calcium chloride, so absorbs any water which may be driven off from the caustic potash solution by the heated gas. H and K are filled with caustic potash and calcium chloride to rid the atmospheric air of its carbon dioxide and moisture.—*Industrial Review.*

## ANTOINE LAURENT LAVOISIER.

THE science of chemistry is aptly said to be based upon the foundations laid by three men, Lavoisier, Priestley, and Scheele. Just as physics had been hampered by the material theory of heat or "caloric," so chemistry had been retarded by the phlogiston theory. Facts had accumulated. The work of Scheele's life had brought the knowledge of chemical compounds wonderfully forward. Yet the weight-annihilating phlogiston, similar to the "negative gravity" of Stockton, the novelist and story writer, had prevented the formulation of a tangible theory. Lavoisier was one of the first to apply rigorous quantitative methods to chemistry. He made the balance the arbiter of all questions. He found that a substance invariably gained weight in burning, and determined the amount of this increase. According to the chemistry of those days, of Stahl and the scientists of his age, burning was dephlogisticating, or removing phlogiston from the substance burned. Thus, if metallic tin was calcined, producing invariably a quantity of oxide exceeding in weight the original tin, it was assumed that phlogiston had been removed from it, and this removal was assumed to increase the weight.

In 1774, Priestley discovered that by heating red oxide of mercury a gas was produced. He confined the oxide of mercury in an inverted bell jar, where it floated upon metallic mercury with which the rest of the vessel was filled. The oxide was pressed upward by the metal against the top. By a burning-glass he concentrated the rays of the sun upon the oxide thus confined, whereupon the level of the metal rapidly sank as the gas was evolved. The gas was oxygen. About the same time Scheele also discovered it, but did not make known his results.

This discovery was the death blow to the phlogiston

education. A student at the Mazarin College, he gave much attention to the natural sciences. The astronomer La Caille, the chemist Rouelle, and botanist De Jussieu, names now almost forgotten, are mentioned among his preceptors. Among his first researches may be mentioned his work on the illumination of the streets of large cities. In those days, before the invention of gas, it was a most serious problem how to properly light the cities. Crime took every advantage of the darkness that prevailed. To qualify himself for this investigation he lived in a darkened room for six weeks, in order to increase the sensitiveness of his retina. For his memoir on the subject, presented in 1766, he received a prize from the Paris Academy of Sciences. In 1768 he was admitted to the Academy in virtue of this and other essays, some on geological subjects. In 1776 Turgot put him at the head of the *regie des salpêtres*, to whose charge was confided the powder manufacture of the kingdom of France. Into this art he at once introduced important improvements, that made the French gunpowder one third stronger than formerly. From 1778 to 1785 he gave much attention to scientific agriculture. In 1787 he was a member of the Orleans provincial assembly. He had a part in preparing the new decimal system of weights and measures in 1790. In 1791 he became commissary to the treasury, and established a new and unheard of system of punctuality. At the request of the national assembly he set forth a scheme of national taxation, and his memoir on the subject shows him to have been a skillful political economist. In 1769 he had obtained the position of farmer-general of the revenues, and had held it for twenty-one years. He had obtained it in order to have sufficient revenue to devote himself exclusively to science. His position was made the basis of an accusation against him.

The farmers of the revenue of a preceding genera-

The portrait is from a painting by the great David. It is curious that David, who voted in the national assembly for the death of Louis XVI., should have been the painter of Lavoisier's portrait, who himself was a victim of the revolution. It makes the painter in some sort responsible for the death of the greatest of France's chemists, him whose features he himself had with such inspiration transferred to canvas. The death of Lavoisier reminds us of the death of Archimedes. Both are blots upon the pages of history.

He was married in 1771 to Mlle. Paulze, but left no posterity.

The last of Lavoisier's memoirs on physiology was one embodying the results of experiments undertaken by him in consort with Seguin, and which, after being read at the Academy on April 14, 1790, was not published until 1797, by the efforts of Seguin (see *Oeuvres Complètes*, vol. ii., p. 704). But later than this period Lavoisier continued his researches, as the following letter to Black testifies, which is in Lavoisier's minute autograph:

M. Black, Professor in the University of Edinburgh. Sent November 13, 1790.

M. Terray, monsieur, forwarded to me, on reaching Paris, the letter you did me the honor to write on the 24th of October. He could have made me no more agreeable present. I believed that you would not object to my communicating it to the Academy of Sciences. The elegance of the style was no less admired than the depth of philosophy and clearness that pervades your letter, and I was requested by it (the Academy) that it should be deposited in its archives, but I only consented to this on condition that a copy certified to by the secretary should be sent to me. I have another favor to ask of you, but concerning which I await your instructions. It is to permit me to publish a translation of it in the *Annales de Chimie*.\*

M. Gillan, during his sojourn in Paris, witnessed some experiments which I made upon respiration, and he was so kind as to assist in them. We convinced ourselves of the following facts:

1. The quantity of vital air, or oxygen gas, which a man at rest and fasting consumes, or, rather, converts into fixed air or carbonic acid, during one hour, is about 1,200 French cubic inches, when he is placed in a temperature of 26 degrees.
  2. This quantity rises to 1,400 inches under the same circumstances if the person is placed in a temperature of only 12 degrees.
  3. The quantity of oxygen gas consumed or converted into carbonic acid increases during the time of digestion, and rises to 1,800 or 1,900 inches.
  4. By movement and exercise it may be raised to 4,000 inches per hour, and even more.
  5. The animal heat is constantly the same in all the cases.
  6. Animals can live in vital air or oxygen which is not renewed as long as is judged proper, provided care is taken to absorb by caustic alkali liquor the carbonic acid gas as fast as it forms, so that this gas does not need azote or mophette gas, as has been believed, to be salubrious or fit for respiration.
  7. Animals do not seem to suffer in a mixture of fifteen parts of azote gas and one part of oxygen gas, provided one takes the precaution of absorbing the carbonic acid gas by means of caustic alkali as fast as it forms.
  8. The consumption of oxygen gas and its conversion into carbonic acid is the same in pure oxygen gas and in oxygen gas mixed with azote gas, so that the respiration is not at all accelerated on account of the purity of the air.
  9. Animals live quite a long time in a mixture of two parts of inflammable gas and one of oxygen gas.
  10. Azote gas performs absolutely no service in the act of respiration, and it leaves the lungs in the same quantity and quality with which it entered.
  11. When by exercise and motion the consumption of oxygen gas in the lungs is increased, of which it is easy to assure one's self by the beating of the pulse, and in general when a person breathes without disturbing himself, the quantity of oxygen gas consumed is proportional to the increase of the number of pulsations multiplied by the number of inspirations.
- It is proper, sir, that you should be one of the first to be informed of the progress which is made in a career which you have opened, and in which we all regard ourselves as your disciples. We pursue the same experiments. I will have the honor to inform you of our later discoveries.

I have the honor to be, with a respectful attachment, etc.

## TAKING A BULLET FROM THE BRAIN.

THE instances when men have carried bullets in their brains and lived are nearly as rare as the fabulous hen's teeth. Colonel Henry Pickens, who was discharged from Bellevue Hospital recently, afforded a notable case. He was an officer in the Confederate army. His home is at Lexington, Ky. He was wounded at the battle of Gettysburg in 1863. Since that time he has carried a bullet constantly in his brain. It gave him pain from time to time, varying in intensity. Of late years it had been more painful. Physicians who were acquainted with his case told him that it would kill him, yet he went home to Lexington, sound in body and mind, with the bullet extracted. How narrowly he escaped death may be gathered from the particulars of his case.

Nearly eight weeks ago the bystanders at the corner of Broadway and Fourth street saw a well dressed man walking slowly up the street, leaning heavily on a cane. Just as he got to the corner he staggered against a window. He seemed to recover his balance by the power of will, but after taking a few more steps he stopped suddenly, raised his hands to his head, and fell prostrate. Blood oozed from a wound in the forehead where he had struck. An ambulance was summoned. It was some time before it came clattering along the street, sounding the sharp gong. The ambulance surgeon saw that the prostrate man was breathing heavily. There was no odor of alcohol about him. He was picked up and hurriedly driven to the hospital. There was nothing in his clothes to lead to his identification. The word "unknown," that is so often written on the records of the hospital, was entered in the book at the end of a brief description of his appearance.

From what could be learned about the case, it was

\* Black's letter appeared in the *Annales de Chimie* of 1791 (vol. viii., p. 230).



LAVOISIER.

theory of chemistry. The anomalous phlogiston, the weight-destroying substance, was done away with forever. A year after his discovery Priestley went to Paris, and communicated his results to Lavoisier. The latter was in the full tide of his work of reorganizing chemistry. The discovery of oxygen gave him the stepping stone on which to build his theory. Scheele by his long life of discoveries had furnished additional facts for the new science. Lavoisier by his severely logical mind and wonderfully perfect methods of working founded the science as an entirety.

Lavoisier calcined a weighed amount of tin, and had weighed the oxide produced. He burned the diamond, and found that carbonic acid gas was produced. He acted upon air with phosphorus, and found that one fifth of its volume disappeared. The discovery of oxygen, communicated to him by the English theologian Priestley, gave the clew to the explanation of all these facts. Here was a weight-possessing element that produced oxidation, so that the latter phenomenon became one of combination instead of dissociation. At once the new chemistry was built upon this foundation. So eagerly did Lavoisier promulgate the new theories that he excited jealousy among his brother scientists, a jealousy which, in the extraordinary days he lived in, may have contributed to his death at the hands of the French revolutionists. So great was his part in laying out the new scheme of chemistry that the French, with much reason, claim it as a French science. Thus he established the constitution of oxides, of oxygen acids, and of oxygen salts. For many years the haloid salts were considered, under the impetus of the new discovery, to also contain oxygen. He determined the constitution of metallic sulphides.

The recent discovery of a hitherto unpublished letter by Lavoisier is the motive of thus presenting his portrait. The letter will be found below. The leading features of his life may be properly summarized here.

He was born in Paris, in August, 1743. His father was wealthy, so that he enjoyed every advantage of

tion had accumulated immense fortunes from their positions, and had led lives that by their extravagance and luxury were a standing reproach to the system. This had been reformed under Louis XVI., and the farmers of the revenue of the time were free from cause for reproach. But they had to suffer for the sins of their predecessors, though innocent themselves.

In 1793 the subject was brought before the national assembly. A series of accusations were made, and most of the farmers were placed under arrest. Lavoisier had eluded the police, but fearing that his absence would affect the others unfavorably, gave himself up. The story of the proceedings is told at great length in the *Revue des Deux Mondes* of Feb. 15, 1887. To this we must refer our readers for the details of the proceedings. A series of frivolous and unproved charges was enough to bring them all to the guillotine. Lavoisier anticipated the confiscation of his property, and had resolved to practice pharmacy for his living. He was desirous to collect his writings for publication. But the temper of the times did not permit this. On the 6th of May, 1794, he, with twenty-seven other farmer-generals, was condemned to the guillotine, and on the 8th of May the sentence was executed. He was engaged in preparing a collection of his works, but his execution came before he had completed it.

His great work was in chemistry. Eagerly availing himself of the discovery of Priestley, and of his own work on carbonic acid gas, embodied in a memoir of 1792, he applied his unequalled intellect to the plan and theory of the science, and became the founder of modern chemistry.

The letter whose translation we give below shows what marvelous quantitative work he executed. In this he was half a century in advance of his time. As has just been stated, he remorselessly applied the balance to testing the theory of chemistry, and the results described in this letter show how well he did his work.

The engaging tone of modesty and candor are very noticeable, and display a most amiable character.