

leaves. This difference, however, is easily explained; in the leaves the green matter is united with the parenchyma by the aid of capillary affinity, and this union or combination is not broken by water, but by a sufficiently strong alcohol.

The following experiment gave an apparent verification. Fibers of cotton and linen immersed in a solution of phyllo-cyanate of potassium united with the coloring matter; the latter was not re-extracted by water, though by alcohol and ether, as in the case of green leaves.

Therefore—to recapitulate the results—it is a proven fact, that the coloring matter of leaves is a mixture of phylloxanthin and phyllocyanate of potassium.

It has long been known that leaves in autumn generally lose their green appearance, changing to yellow, and also give off a large portion of their alkali. Now we know that this process depends upon the decomposition of the phyllo-cyanate of potassium.—*Pharmacist.*

**CHEMICAL COMPOSITION OF MINERAL COAL.**

Abridged from *Comptes Rendus* for the *Franklin Journal* by PLINY EARLE CHASE, LL.D.

FOR nearly thirty years Prof. E. Fremy has been studying vegetable tissues, with especial reference to the chemical nature of the principles which they contain, and the influences which have changed them into lignite, bituminous coal, and anthracite. He began with examining the vegetable skeletons. The substances which he first studied were almost wholly unknown; their characteristic property is their production, under the influence of a ferment or of reagents, of gums and gelatines. He showed that they are all derived from a primitive insoluble compound which he called *pectose*, represented in its greatest simplicity by the formula  $C_5H_8O_7$ , and which by successive polymeric transformations, forms at first gummy substances, then gelatinous bodies, and finally an acid soluble in water.

He then began the study of the stable elements which form the fibers, cells, and vessels. He found that the vegetable framework is not so simple as he thought; it is not built up of simple cellulose differently incrustated by other substances, but of many kinds of isomeric cellulose. There is also in nearly all parts of the skeleton a very important body which differs from the celluloses in composition and properties, which abounds in the vessels, and which he therefore calls *vasculose*. The proportions in which it exists in different kinds of wood affect their physical qualities. Oak may contain 30 per cent.; in walnut shells there is sometimes 50 per cent. It binds the woody fibers together. Caustic alkalis dissolve it, and they are therefore employed in the manufacture of wood paper.

After ascertaining the composition of the internal tissues, he analyzed the cuticle and other coverings, discovering *cutose*, which is well fitted, by its resistance to chemical change, for protecting the parts which are exposed to the air.

Passing next to the bodies which are most often found in the tissues, he showed that gum is a true salt of lime, and that chlorophyll owes its green color to a salt of potash.

In extending his studies to combustible fossils, he first sought what chemical differences characterized wood, peat, the different lignites, bituminous coal, and anthracite. He found that wood is not sensibly attacked by a dilute solution of potash, while peat often yields to that alkali considerable quantities of ulmic acid; xyloid lignite, or fossil wood, still contains notable proportions of ulmic acid, but it is easily distinguished from wood and peat, because it is changed into yellow resin by nitric acid, and it is completely soluble in hypochlorites; compact or perfect lignite contains no appreciable ulmic acid, and still it is dissolved in nitric acid and the hypochlorites; as to the true coals, they are characterized by their insolubility in neutral solvents, acids, alkalis, and hypochlorites.

In his synthesis he was guided by the experiments of Daubrée and Baroullier, which indicated the importance of heat and pressure in coal metamorphosis. He performed a series of experiments, in which vegetable tissues and the substances which most often accompany them in organization were separately kept for a considerable time, at temperatures from 200° to 300° (392° to 572° F.), in hermetically sealed glass tubes. He found that cellulose, vasculose, and cutose all become black, brittle, yielding water, acids, gas, and tar, but preserving their organization; they did not melt, but gave a fixed product which showed no resemblance to mineral coal. With sugar, starch, gum, chlorophyll, and the fatty and resinous bodies which accompany it in the leaves, the results were very different. By long calcination under pressure they became black, shining, often melted, absolutely insoluble in the tested chemicals, and very different from charcoal, for when heated to redness they behaved like organic bodies, yielding water, etc., but having as a fixed residuum a hard and brilliant coke. The chemical resemblance to a specimen of Blanzoy coal, which was analyzed by Regnault, is thus shown:

	Carbon.	Hydrogen.	Oxygen.	Ashes.
Coal from sugar	66.84	4.73	28.43	—
“ “ starch	68.48	4.68	26.84	—
“ “ gum arabic	78.78	5.00	16.22	—
Blanzoy coal	76.48	5.23	16.01	2.28

He was induced to experiment on these three substances because, according to Ad. Brongniart, they must have abounded in the vegetables which produced the coal beds, and because gum often comes from the transformation of tissues, as Trécul has shown.

Further experiments led him to the dominant hypothesis that vegetables are first changed into peat, and that in that form the disappearance of the organized tissues is due to a kind of turfy formation, as Van Tieghem suggested. He then operated on three kinds of ulmic acid: 1, acid which he had himself extracted from peat; 2, saccharulmic acid, which he obtained from M. P. Thenard; 3, ulmic acid extracted by treating vasculose by alkalis. They were all transformed into substances similar to the foregoing, under the combined influence of heat and pressure, as is shown by the following analysis:

	Carbon.	Hydrogen.	Oxygen.
Coal from peat acid, heated 24 h.	67.48	5.84	26.68
Same, heated 72 hours	71.72	5.03	23.25
“ “ 120 “	76.06	4.99	18.95
Coal from vasculose acid	76.43	5.31	18.26

Finally he examined the modifications, under heat and pressure, of mixtures of chlorophyll with the fatty and resinous bodies which alcohol extracts from leaves. Although the mixture was at first soluble in alkalis, after 150 hours' treatment it gave a black substance, viscous, insoluble in caustic alkalis, and presenting an evident analogy to natural bitumens.

**ON THE SIZE OF MOLECULES.**

By N. D. C. HODGEA

If we consider unit mass of water, the expenditure on it of an amount of energy equivalent to 636.7 units of heat will convert it from water at zero into steam at 100°. I am going to consider this conversion into steam as a breaking up of the water into a large number of small parts, the total surface of which will be larger than that of the water originally. To increase the surface of a mass of water by one square centimeter requires the use of 0.000825 milligramme of work. The total superficial area of all the parts, supposing them spherical, will be  $4\pi r^2 N$ . The number of parts being  $N$ , the work done in dividing the water will be  $4\pi r^2 N$ . For the volume of all the parts we have  $\frac{4}{3}\pi r^3 N$ . This volume is in accordance with the requirements of the kinetic theory of gases, about  $\frac{1}{3000}$  of the total volume of the steam. The volume of the steam is 1,752 times the original unit volume of water.

$$\text{Hence } \frac{4}{3}\pi r^3 3000 = 1,752$$

$$4\pi r^2 \cdot 000825 = 636.7423.$$

One unit of heat equals 423 milligrammes. Solving these equations for  $r$  and  $N$ , we get  $r$  equal to 0.00000005 centimeter, a quantity of the same order of magnitude as has already been obtained by Thomson, Maxwell, and others,  $N$  equal 9,000 (million)<sup>2</sup> for the number in one cubic centimeter 5 to 6 (million)<sup>3</sup>.

Around every body there is an atmosphere of more or less condensed gases. On the surface of platinum these must be nearly in the liquid condition, as shown by the power of platinum to bring the atoms of hydrogen and oxygen so near together that they combine. These vapors on the surface have a tendency at ordinary temperatures to expand; and part of them can do so, if the surface of the body is reduced. There is in these condensed atmospheres an explanation of all the phenomena of superficial tension. The energy in the unit of area ought to be equivalent to the amount of work done in compressing a quantity of the vapor from the gaseous to the liquid state sufficient to cover the surface a few molecules deep. The molecular attraction seems to be very slight in gases, when the molecules are ten to fifteen molecular diameters apart. To get some idea of the amount of work done in compressing one gramme of oxygen to liquid form, we may consider that in the union of one gramme of hydrogen with eight grammes of oxygen 34,462 units of heat are produced. It matters not that the condensation is brought about by the energy of chemical separation rather than by the work done in pressing them together in a cylinder.

The superficial energy of platinum is 169.4 milligrammes per square meter, or 0.01694 per square centimeter, equal to 0.00004 of a unit of heat. The proposition

$$9 : 34,462 :: x : 0.00004$$

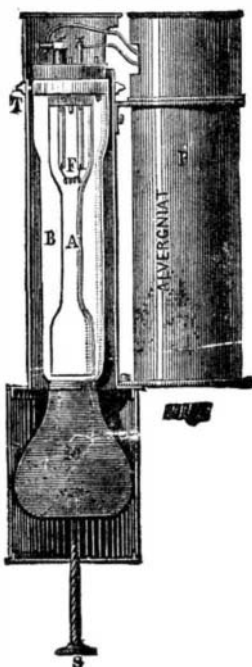
gives the weight of water condensed on one square centimeter of surface, or the volume in cubic centimeters as 0.00000001, which agrees with the other result.—*Amer. Jour. of Science.*

**APPARATUS FOR MEASURING FIRE DAMP.**

THE principle of this apparatus is based upon the property of palladium, when in a red hot state, of oxidizing fire-damp (carbureted hydrogen) into carbonic acid gas and water. The apparatus is constructed by Mr. Coquillon in two different shapes, namely, the *grisometre portatif* and *grisometre fixe*. Fig. 1 represents the portable grisometer. With it the quantity of fire damp contained in the air can be determined at any place in a very short time.

A represents a graduated glass cylinder, open at the bottom, but closed on top by a perforated rubber stopper. A palladium wire, F, passes through two of these perforations, and is connected with a battery by means of binding screws. A small glass tube, open below but closed on top, also passes

Fig. 1.



through the stopper. The tube, A, is inclosed in a larger glass tube, B, also provided with a rubber stopper, through which another small tube like the one just described passes. A vessel, M, the bottom of which is composed of some membrane, is attached to the lower end of B. All these parts are incased in a sheet metal box or cylinder provided with two vertical slots for the purpose of enabling a person to read the scales. Before operating with the apparatus it is entirely filled with water. By opening the two small glass tubes and pressing the membrane upwards by the screw, S, a certain quantity of the gas or air to be examined can be admitted into the cylinders, A and B. The two small glass tubes are then closed, and the palladium is heated until it is red hot by means of the battery. As soon as the carbureted hydrogen is oxidized the levels in the two cylinders are made equal, the scales will indicate their position, and from the diminution of the water the quantity of carbureted hydrogen can be determined.

The fixed grisometer (Fig. 2) is adapted for measuring larger quantities of air. A is the graduated tube, B the palladium wire, C is a tube containing the gas or air, and F is

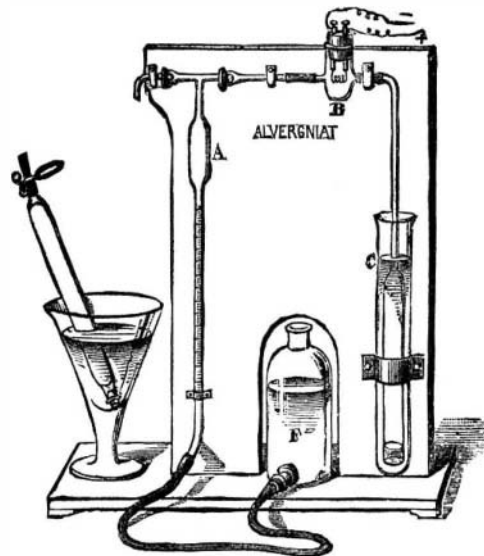


Fig. 2.

vessel containing water. If the quantity of carbureted hydrogen is over 9 per cent., it will be necessary to mix the gas with air, as there always must be a surplus of oxygen. If a closed tube, D (Fig. 3), containing lye, be added to the apparatus, the same can be used for measuring any carbureted

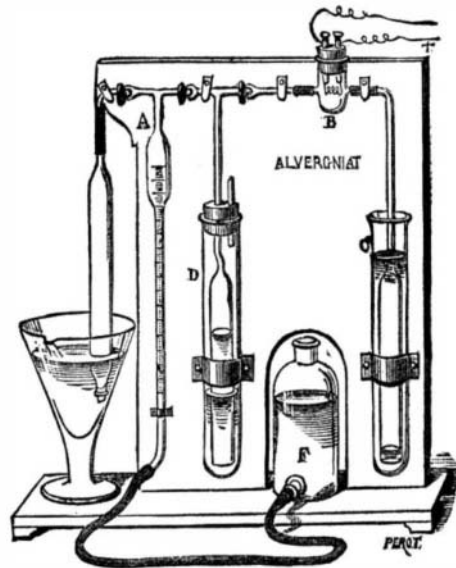


Fig. 3.

gas, and is then known as the carbometer. For complicated gases it will be necessary to insert several tubes into D.—*Chemiker Zeitung.*

**ALIZARIN CARMINE.**

A NEW coloring material is manufactured under this name by the Austrian Alizarin Manufacturing Company. With tin as a mordant, it dyes wool orange; with alum, red. It is said to surpass all previous dyes of similar tints in beauty, brilliancy, durability, and variety of shading with different mordants, and resistance to change under exposure to light, air, perspiration, and washing.—*Fortschr. der Zeit.*

**EXTRACTION OF GREEN COLORING MATTER FROM COFFEE.**

M. ZECH announces his discovery of a simple method by which an innocuous green pigment, suitable for coloring sweetmeats, preserved vegetables, etc., may be extracted from coffee. The berries are first soaked, and the oil then removed from them by the action of alcoholic ether. They are then dried, and shaken up with white of egg, and the species of marmalade thus obtained exposed to the atmosphere for a few days. The presence of the albumen of the white of egg determines the appearance of a magnificent emerald green. Another equally easy way of obtaining the coloring matter is to simply steep the berries in water, after they have been bruised, and deprived of their oil by washing with alcohol.

**CONVEYING ACIDS.**

M. KUHLMANN, in place of carboys, employs floating reservoirs in the form of an ordinary boat, fitted with air chambers to give them sufficient buoyancy. For sulphuric acid of 60° B. and upward these are constructed of sheet iron, and have been in successful use for some years on the canals of the north. For hydrochloric acid he uses cylinders of hardened India-rubber, kept in their form by an external framework of wood. A modification of the structure serves for transport by rail.

**M. GAIFFE'S GALVANIC DEPOSITS OF COBALT.**

THE metal is deposited from a solution of the double sulphate of cobalt and ammonia, and is superior to nickel at once in hardness, tenacity, and in beauty of color. It is much less oxidizable than iron, but is very easily dissolved by acids.

**BLEACHING OSTRICH FEATHERS.**

ACCORDING to the *Moniteur des Produits Chimiques*, feathers are bleached in a bath of 10 grms. barium peroxide to 1 liter water, heated to 30°. In this they remain for forty-eight hours, and are then washed, treated with weak hydrochloric acid, and dried.