there are besides two or three small annexes, and a court in the Fine Arts Gallery.

The United States of North America are adjacent to England. Coming very late in the field, a place of honor has nevertheless been reserved to them, and one which will be well filled despite the shortness of time at the disposition of exhibitors. The United States Agricultural Building is an extension of that of Great Britain. Belgium and Austria both have very important allotments, and we imagine that the exhibits of Belgium and Switzerland will rank next in importance to those of France and England. Both countries, standing in the first industrial rank, have shown great enterprise in taking so large a part in the Exhibition, especially in the section devoted to machinery.

Italy has a large area, and though it is too much to expect that when the exhibits of this country are finally arranged they will display much of high value in the mechanical arts, they have spared no pains to take a foremost place in other industries. Of Sweden and Norway there is no need to speak. What they did at Vienna and Philadelphia is a guarantee of their collections now. Spain, too, is largely interested, and China and Japan are now known at exhibitions as very important contributors. Holland, Portugal, Denmark, South America, all the countries, in short, are here, and all have done their utmost to crown this great triumph of French energy and power. That is, all but Germany, who, unfortunately for the rest of the world, and we believe for herself, declined to participate. True she shows some pictures, but we may look in vain for the display which was conspicuous at Vienna. Germany's decision was, however, fortunate in some respects for other countries, since had she elected to be present, room for her must have been made at the expense of others.

By the system of classification adopted, the contents of the Exhibition are divided into nine groups, subdivided into ninety classes.

THE NEW METAL GALLIUM.

THE metal gallium, which is the latest discovery among the recognized elements, was first seen by M. Lecoq de Boisbaudran in the autumn of the year 1875, and so named by him in honor of the land of its discovery, France. Like its four predecessors made known within the last 20 years, gallium was discovered by the process of spectrum analysis, applied in this instance in a special manner contrived by the ingenuity of M. de Boisbaudran himself, long eminent as a spectroscopist. The spectrum of gallium is characterized by two marked violet lines, the less refrangible of them being especially brilliant. Hitherto the new metal has been recognized only in certain varieties of zinc blende, that of Pierrefitte in the Pyrenees having furnished the chief portion of gallium hitherto obtained from any source whatever—nearly half a ton of this ore having been employed by M. de Boisbaudran to furnish the dozen grains or so of metal wherewith he has been able to establish the leading properties of the element. In its appearance gallium manifests a general resemblance to lead, but is not so blue-tinted or quite so soft, though it is readily malleable, flexible, and capable of being cut with a knife. Like lead again, and unlike zinc, gallium is not an easily volatile metal. Unlike lead, however, it acquires only a very slight tarnish on exposure to moist air, and undergoes scarcely any calcination at a red heat. The specific gravity of gallium is a little under 6, that of aluminum being 2.6, that of zinc 7.1, and that of lead 11.4. A most remarkable property of gallium is its low melting point. It liquefies completely at 86° Fah., or below the heat of the hand; and, still more curiously, when once melted at this temperature, it may be cooled down even to the freezing point of water without solidifying, and may be kept unchanged in the liquid state for months. Indeed, in the original communication of its discovery to the French Academy, it was described as a new liquid metal, similar to mercury; but on touching with a fragment of solid gallium a portion of the liquid metal in this state of so-called suffusion it at once solidifies. Unlike lead, again, gallium is a highly crystalline metal, its form being that of a square octahedron. In its chemical habits the rare element gallium shows the greatest analogy to the abundant element aluminum. In particular it forms a sort of alum not to be distinguished in its appearance from ordinary alum, but containing oxide of gallium instead of oxide of aluminum or alumina.

But the chief interest of gallium, from a scientific point of view, is connected with the history of its discovery. All previously known elements have been discovered, so to speak, accidentally, and their properties have been not in any way foreseen, but rather met with as subjects of surprise; but the blende of Pierrefitte was deliberately taken up for examination by M. Lecoq de Boisbaudran in the expectation of finding a new element. The existence of an element having the characteristic properties of gallium was, moreover, upon entirely different grounds, predicted very definitely by a Russian chemist, M. Mendeleeff, in 1871, and in a more general way several years earlier by an English chemist, Mr. Newlands. This double prediction was based on a study of the relations of the known atomic numbers of the elements. These numbers have only lately been perceived to form a tolerably continuous series, which, again, is associated in a remarkable manner with the series in properties of the elements themselves. In the series of numbers, however, certain terms are here and there missing, and in particular a number was missing which should belong to an element having properties intermediate between those of aluminum and iridium. What these properties would be was predicted in most minute detail by M. Mendeleeff in 1871. He predicted, for example, that the specific gravity of the missing metal would prove to be about 5.9. Operating on very small quantities, M. de Boisbaudran, in the first instance, found the specific gravity of gallium to be 4.7; but on repeating his determination in 1876, with special precautions and on a somewhat larger though still very small scale, he found it to be exactly 5.935, certainly a most remarkable fulfillment of the prediction with regard to it.

In a recent number of *La Nature*, M. G. Tissandier gave the following account of the extraction of a quantity of gallium by M. de Boisbaudran, accompanied by a description of some of its properties:—Without shrinking from the delicate and frequently troublesome operations necessary in treating a mass of blende weighing 4,300 kilogrammes, he has succeeded, in collaboration with M. E. Jungfleisch, in getting out 62 grammes of gallium. "If," say these gentlemen, "we take account of inevitable losses and of a few grains of gallium remaining in the various products of our operations, we may estimate the proportion of gallium in Bensberg blende at about one part in sixty thousand, or 16 milligrammes per kilogramme. The small proportion of matter to extract will sufficiently explain the large amount of time consumed in its extraction."

The preliminary operations were carried out at the works at Javel belonging to M. Léon Thomas, a successful manufacturer as well as patron and student of science. The 4,300 kilogrammes of blende were concentrated in a mass weighing about 100 kilos., containing the whole of the gallium. From Javel this mass of concentrated stuff was transported to the laboratory of M. Lecoq de Boisbaudran at Cognac, and, after further concentration, was purified and reduced to a metallic condition at the Ecole de Pharmacie, at Paris. After a long succession of attacks by acids and alternative precipitations, the metals associated with gallium, such as zinc, iron, cadmium, iridium, &c., were eliminated. The gallium in the residue of the solutions from which the other metals had been separated was got in the metallic condition by the action of the electric current.

"The deposition of metallic gallium," say Messrs. Lecoq de Boisbaudran and Jungfleisch, "is only carried out successfully under certain special conditions. The intensity of the electric current, for instance, should vary with the state of the solution, but the surface of the negative electrode should always be small, relatively to that of the positive electrode. In one of our operations, by which we got 8 grammes of gallium in twenty-four hours, forty Bunsen cells (18 centimeters high), acted on eight parallel rows, each of five cells in tension, acted on a negative electrode, the double surface of which did not exceed 15 square centimeters, while the positive electrode had a development of about 450 square centimeters. The metal on being thrown down cold frequently forms long threads of crystals which take on the appearance of needles, fixed normally to the electrode by one of their extremities; some few have reached the length of 3 centimeters. Above 30° the metal runs in drops, which coalesce at the foot of the electrode." Crystals of gallium were presented on behalf of the operators to the Academy of Sciences by M. Berthelot, in its sitting of February 18th. These crystals, which have a distinct grayish-blue metallic luster, belong distinctly to the octahedric system, but their angles have not yet been measured, their faces being slightly rounded. They are mounted on small glass stems, and kept under a glass globe from the contact of the air.

Crystallization was effected by introducing a platinum wire carrying a particle of solid gallium into the metal cooled to 10° or 15° C. below its melting point. After the lapse of a very short period, varying from 3 to 10 seconds, octahedric crystals show themselves, very slightly modified at their summits by traces of their base. The crystals were shown in the accompanying drawings of the full natural size. If the crystals are not promptly withdrawn as soon as formed, the metal reacquires part of its lost heat, solidification slackens and the base enlarges.

Gallium is a hard and malleable metal; it takes under the hammer the polish of the anvil, but rapidly grows harder and brittle, and is then liable to fly to pieces. In spite of its relatively considerable hardness, gallium leaves on paper strongly defined marks of a bluish-gray color. It retains its luster in the atmosphere of a laboratory constantly loaded with acid vapors, and undergoes no alteration in appearance in boiled water. In aerated water it tarnishes slightly.

Gallium, which melts at 30°, may be kept superfused in a tube hermetically sealed. MM. Boisbaudran and Jungfleisch have prepared a certain quantity of it in this condition. It remains fluid like mercury, and when the tube is inverted it creeps along the glass like melted wax. In a liquid condition, gallium has the brilliant whiteness of tin or silver. It would be of great value for the determination of temperatures rising to 300° or 400° C., but its habit of clinging to the sides of the glass vessel in which it may be contained constitutes at present an impediment in the way of its being used for thermometric purposes. It is possible that some means may be found for correcting this tendency, and that the new metal may thus be made capable of receiving various applications in the domain of experimental science.

Gallium leaf has also been prepared by running the melted metal between heated glass surfaces. On cooling, especially if the cooling is carried out under water, the metal is easily detached from the glass. This specimen melts in the hand; it retains its characteristic dull blue metallic reflection. A small bar has also been cast, the elasticity and malleability of which are easily demonstrable.

Crystallized gallium prepared cold by electrolysis of a potassic solution decrepitates on being thrown into hot water, and gives rise to bubbles of gas. "By electrolysis of a liquor heated up to 30° C.," say the experimenters, "we have often obtained, especially toward the end of the operation, a puffy metallic mass swelling in warm water, and having the aspect of an ammonium amalgam. Kneaded in water at 40° C., this mass contracts and is finally resolved into ordinary fluid gallium."

Some new compounds of gallium, comprising the chloride, bromide, and anhydric iodide, have been presented to the Academy. Chlorine attacks gallium in the cold state very actively, with an abundant disengagement of heat. The product is faintly yellow; it would probably be perfectly colorless if pure. It is well crystallized, very fusible, easily becomes volatile, and imbibes the ordinary moisture of the atmosphere. The action of bromine is less energetic than that of chlorine. To get the iodide it must be slightly heated."

GLUCINIUM.

By L. F. NILSON AND O. PETTERSSON.

GLUCINIUM in its salts presents certain analogies both with the magnesium and with the aluminium group, but no decisive clew is afforded to the true atomicity of the metal, which can only be deduced from its specific heat. The preparation of the metal is difficult; the authors could not succeed in obtaining it from its chloride by the electric method, and they adopted, therefore, the process of Wöhler and Debray, decomposing the chloride with potassium or sodium in a wrought-iron crucible closed with a screw. Glucinium thus obtained is a steel or tin-gray metal, of the sp. gr. 1.901 at 0°. It is hard and crystallizes readily. If melted it breaks under the hammer, and does not fuse at a temperature where salt is readily volatilized. It is inalterable in the air, and even at a red heat in a current of oxygen. Vapor of sulphur does not affect it. Before the oxidizing flame it becomes covered with a layer of oxide, but does not take fire. It has no action upon water either warm or cold. It decomposes hydrochloric and hydrosulphuric acid and the alkaline hydrates, hydrogen being evolved very briskly if heat is applied. Nitric acid attacks it more slowly. The sp. gr. of the impure metal being 1.9101, that of pure glucinium from its known composition was calculated at 1.64. The specific heat of glucina between 0° and 100° is 0.2471. Hence it must be considered analogous to aluminium, its atomic weight being 13.8, and its oxide having the formula Be_2O_3 .

JAPANESE ISINGLASS.

By HARRY NAPIER DRAPER.

THIS product was given to me some time since by Dr. Aquilla Smith, who had procured it in the London Docks. It is in the form of flattened, somewhat contorted, and always curved threads, the longest of which does not exceed six centimeters, and they may perhaps be as accurately as possible described by saying that they resemble in form Nelson's Opaque Gelatine, but are very much more opaque and have much less color. That the substance is not isinglass may be at once decided by burning one of the threads, when it will be found that no odor of charred animal matter is evolved. Shortly summed up, the properties of this body are as follows:—It is turned blue by iodine, and is insoluble in alcohol, water even after many hours' boiling, dilute potash solution, acids, ammonia, and ammoniacal copper sulphate. My friend, Dr. Richardson has been kind enough to make for me two sections of this substance. These examined by the microscope show a ruptured cellular structure, but no indications whatever of starch granules. I bring forward this note in order that those whose attention may be called to it, and who may have met with this or other allied substances, may be induced to communicate any information of which they may be possessed. I should myself have pronounced it to be the Gelose of Payen, a body extracted from *Gelidium Cornutum* and other *Algæ*, were it not that this substance is described as being soluble in boiling water, and as yielding a translucent jelly, while the so-called "Japanese Isinglass" is quite insoluble. Nor in the descriptions of Payen's Gelose which I have seen is it mentioned that it is colored by iodine. At the time, now nearly a year since, when Dr. Smith gave me this specimen, I made several inquiries in London as to its existence, sources and uses, but without the slightest success.

Although not true isinglass, it seemed possible that the article under examination might be some other product of the animal kingdom. This would involve the question whether or not it contained nitrogen.

This point may be decided by a qualitative test, which, being applicable to all such cases, I may be excused for naming, though it is to be found in several modern textbooks of analysis. This test is best applied as follows:—You cut from a clean lump of sodium a few parings with a knife, and intimately mix them on the bottom of a small porcelain crucible, with the suspected substance in as minute a state of division as possible. Then the mixture is ignited. When it has become cool it is heated with water, filtered, and a mixed solution of a per and proto-salt of iron added, and afterward hydrochloric acid. Russian isinglass thus treated gives a copious precipitate of Prussian blue.

Since this paper was read Mr. Grindley has pointed out that this so-called Japanese isinglass dissolves readily in glycerine, and gives a clear and firm jelly. This jelly is colored blue by iodine.

GALLIUM.

By M. BERTHELOT.

M. LECOQ DE BOISBAUDRAN having placed at the author's disposal an ingot of gallium weighing 34 grms., he determined its specific heat, both in the solid and the liquid state, and also its melting heat, making use of his ordinary methods with the water calorimeter. Gallium melts at +30°, but it may be kept liquid in a state of superfusion down to near 0°. The specific heat in the liquid state was determined twice, one experiment between 119° and 13°, and the other between 106° and 12.5°; the value found was 0.0802. The solid specific heat between 23° and 12° was found = 0.079. This determination must not be made too near the point of fusion. The melting heat is determined by introducing some crystals into superfused gallium, when the metal crystallizes rapidly. At 13° the author obtained the mean result +19.11 cal. This number remains sensibly unchanged at all temperatures between 30° and 0°. If referred to the atomic weight, 69.9, it becomes 1.33 cal. The atomic specific heat in the liquid state = 5.59, and in the solid 5.52. This is the same as that of aluminium (5.53) and glucinium (5.64).

ACTION OF OXYGEN UPON THE ACID CHLORIDES, BROMIDES, AND IODIDES OF ALUMINIUM.

By M. BERTHELOT.

THE displacement of chlorine by oxygen with the formation of alumina should disengage a heat about +34.9. The displacement of gaseous iodine in the same manner liberates +109.5, an enormous value, which explains the ignition of aluminium iodide. The same holds good with the iodides of phosphorus, silicon, arsenic, antimony, and tin, which are all combustible. The displacement of gaseous bromine by dry oxygen liberates +62.2.

A NEW WAY OF SEPARATING ARSENIC FROM OTHER METALS.

By MM. DE CLERMONT AND FROMMEL.

SUPPOSING a mixture of arsenic, antimony, and tin, the whole is converted into sulphides by treatment with sulphureted hydrogen, after having acidulated with hydrochloric acid, adding also tartaric acid if antimony is present. When the mixture is saturated it is allowed to stand in a warm place till the odor of sulphureted hydrogen is no longer perceptible, and is then thrown upon a filter and washed with much care, as the least residue of hydrochloric acid would cause a loss of arsenic in the state of chloride. The whole is then transferred into a flask full of water, and heated to a boil. The reaction is more rapid in a retort through which a current of air is passed. If the quantity of arsenic does not exceed 2 decigrams, the distillation of 500 to 600 c.c. of water suffices for the complete dissociation of the sulphides. The residue is then filtered, and the entire quantity of the arsenious acid is found in the filtrate, and determined by the ordinary methods.

DIBROMIDE OF ACETIC ACID.—C. HELL and O. MÜHLHAUSER.—Although bromine and acetic acid do not react on one another in the slightest when brought together, the addition of a minute quantity of CS_2 causes at once a development of heat, and the mixture is changed rapidly into a mass of crystals of the composition $\text{C}_2\text{H}_3\text{O}_2\text{Br}_2$. They form at first orange-colored tufts of needles, but change on standing into red thick prisms. The compound melts at 36°, is excessively hygroscopic, attacks the eyes, and can be sublimed. Water decomposes it. Other liquids, such as CCl_4 or CHCl_3 , do not possess this peculiar catalytic action of CS_2 , which only can cause the formation of this new molecular compound.