two spectra are formed, one from blood on the stage of the microscope, and the other from the same on the stage of the eye-piece.

The dark band of the chlorophyll spectrum is slightly variable in width—and the action of acids and alkalies sometimes causes a slight displacement, the former raising (moving toward the blue end) and the latter depressing. The endochrome of a diatom after treatment with acid is green, and the acid, in this case, produces scarcely any displacement of the band, which may be observed even in the dark reddish mass of the dead Diatomaceæ, almost identical in colour with the ferrous carbonate so often found in bogs where the larger diatoms are abundant; and what is more remarkable is, that the carbonate gives no absorption bands at all. As a general rule, alcoholic solutions of chlorophyll and diatomin have the band slightly depressed, reading 1 to $1\frac{1}{2}$ on the interference scale.—[Amer. Jour. Sci. and Arts.]

CHEMISTRY

Thallium Salts.—I.

MM. LAMY AND DES CLOISEAUX have resumed the study of the principal thallium salts, with the view of ascertaining their chemical composition, optical properties, and crystalline form (Annales de Chimie et de Physique, xvii. 310). The method of obtaining crystals was that which M. Deville has for a considerable time been in the habit of employing in his laboratory. A given substance is placed in contact with water, or some other solvent, either in a closed or lightly covered vessel, and exposed to the usual conditions of temperature of an inhabited apartment; if these do not suffice, the liquid is heated every day for an hour to a certain extent. In course of time, even the most microscopic crystals, if submitted to this process, become large, well-formed, and transparent.

The thallium in these salts was determined as iodide; a compound which from its sparing solubility (especially in water containing a little potassic iodide), as well as on account of its great specific gravity and crystalline character, is very well adapted to the purpose. The density of thallous *sulphate*, Tl_2SO_4, is 6·603,* and its form a right rhomboidal prism, geometrically and optically isomorphous with ammonic sulphate. The crystals often appear unsymmetrical, on account of the unequal development of the different faces. The optic axes are wide apart; and the dispersion of the axes, as observed in oil, is feeble, with $\rho < \nu$. To the already known thallium *alums* may be added a mixed series, having the general formula:

$$(Al_2O_3 . Fe_2O_3)3SO_3 + (K_2O . Tl_2O)SO_3 + 24Aq.$$

Special attention is directed to one of these, which was obtained accidentally in the course of a lixiviation, and had the formula:

$$[(Al_2O_3)\tfrac{2}{3}(Fe_2O_3)\tfrac{1}{3}]3SO_3 + [(K_2O)\tfrac{3}{4}\ (Tl_2O)\tfrac{1}{4}]\ SO_3 + 24Aq.$$

Its colour is slightly yellow, and in solubility it much resembles potassic alum. After several solutions and recrystallisations, the whole of the iron is removed, and the following alum appears:

$$Al_2O_3 . 3SO_3 + [(K_2O)\tfrac{3}{4}(TlO)\tfrac{1}{4}]\ SO_3 + 24Aq.$$

Zinco-thallous sulphate—

$$Tl_2SO_4 + ZnSO_4 + 6H_2O,$$

which had already been described by Willm and Werther, belongs to the oblique rhomboidal prismatic system, and is geometrically isomorphous with ammonio-ferrous sulphate, potassic magnesio-sulphate &c. (as, indeed, Werther has shown); but it is optically different from these salts, both in orientation and in the sign of its acute bisectrix (negative).

Plane angle of the base	107° 5′ 14″
Plane angle of the lateral faces	99° 31′ 24″
Obliquity of the primitive prisms . .	106° 10′ 00″

The optic axes lie in the plane of symmetry. There is a strong proper dispersion with $\rho < \nu$. The *inclined* dispersion is weak, and only brought out by a difference in the brightness of the colours lying at the edges of the hyperbolæ of the two systems of rings. Thallous *nitrate*, $TlNO_3$, has the specific gravity 5·550, and occurs in right rhomboidal prisms of 125° 52′ (the corresponding angle for nitre is 118° 50′). The plane of the optic axes is perpendicular to the corresponding plane in potassic nitrate. The acute bisectrix is negative, and the dispersion of the axes considerable, with $\rho < \nu$. This salt had been already examined optically by Miller. In order to prepare thallous *carbonate*, (Tl_2CO_3), a saturated solution of thallous oxide in alcohol was exposed to air, in contact with a lamina of thallium. At the end of six months, very large crystals were obtained. These have an adamantine lustre, and a specific gravity 7·164; they belong to the clino-rhombic system, thus agreeing neither with plumbic, potassic, nor ammonic carbonate. Macles by hemitropy round one particular axis, are frequently observed. The plane of the optic axes is normal to the plane of symmetry, and almost exactly perpendicular to the base. The acute bisectrix is negative, and normal to the horizontal diagonal of the base; the double refraction energetic. The dispersion of the optic axes is well marked, with $\rho < \nu$; while the *horizontal* dispersion is, on the contrary, inappreciable. An attempt to prepare other thallous carbonates did not succeed.

Di-thallous *phosphate*—

$$2[Tl_2HPO_4] . H_2O,$$

is a very soluble salt, anhydrous at 200°, and crystallises in the rhombic system. Lustre vitreous. The dispersion of the optic axes is strong, with $\rho > \nu$. *Mono*-thallous *phosphate*—

$$TlH_2PO_4,$$

is very soluble in water, and readily crystallises in long voluminous needles which were submitted to the growing process already described. Density 4·723. The crystals may be referred to a clino-rhombic prism of 34° 59′, having a base only slightly sloping towards the lateral faces. Macles by hemitropy are common, giving rise to a re-entering angle of 176° 32′. The plane of the optic axes is parallel to the horizontal diagonal of the base. Acute bisectrix negative; horizontal dispersion indistinct; proper axial dispersion considerable. The *pyrophosphate*— $Tl_4P_2O_7$, crystallises in magnificent transparent prisms, soluble in water with partial decomposition, softened by a heat of 120°, and having the density 6·786. Its form is an oblique rhomboidal prism. The crystals are fragile, and have a somewhat adamantine lustre. The plane of the optic axes is normal to that of symmetry, and almost parallel to the base. While the horizontal dispersion is but slight, the proper dispersion of the axes is the greatest hitherto observed, as shown by the following means of measurements taken in oil and air, determining the apparent separation of the axes in air at 24°:

2E = 125° 48′ (red rays); 112° 30′ (yellow);
2E = 89° 47′ (green rays); 52° 34′ (blue).

The *hydrous pyrophosphate*—

$$Tl_4P_2O_7 + 2H_2O,$$

separates from the mother-liquid of its predecessor. It is soluble in water with but little decomposition; but it is less stable at a high temperature than the anhydrous salt, which, on the other hand, it exceeds in the intensity of its vitreous lustre, its hardness and cohesion. The plane of the optic axes is normal to the plane of symmetry: the acute bisectrix negative and perpendicular to the horizontal diagonal of the base. Horizontal dispersion feeble; proper dispersion of the axes considerable, with $\rho < \nu$. The *ammoniacal thallous phosphate*—

$$3NH_3 . H_3PO_4 + 2NH_3 . H_2TlPO_4$$

is obtained by adding ammonia to the common phosphate, filtering to remove tri-thallous phosphate, and evaporating the mother-liquid. The crystals are very soluble in water, and completely isomorphous with ammonic phosphate. Their figure is that of a right prism with square base, elongated in the direction of the vertical axis, and terminated by an octohedron of 119° 50′. The double refraction is on a negative axis.

E. J. M.

* The temperature in this and following determinations is not given in the memoir.

PHYSICS

Pfaundler on the Regelation of Ice

THE fact observed by Faraday that two pieces of ice freeze together when brought into contact has met with various explanations. Helmholtz, for example, assumes that pressure is always at work in regelation; hence depression of the fusion point of the ice, and a cold sufficient to freeze a small portion of water in another part of the mass. Tyndall, on the other hand, admits the hypothesis of pressure only where it is actually observable; but, in other cases, explains the phenomena by a difference between the fusion-point inside and at the surface of the ice. Schultz has actually verified Tyndall's theory with water from which the air had been expelled.