in the form of its barium salt by suspending freshly precipitated hydrated manganese dioxide in water and passing sulphur dioxide into the mixture until all is dissolved; the barium salt is then pre­cipitated by the careful addition of barium hydroxide. Much manganese sulphate is formed during the reaction, and H. C. Car­penter *(Journ. Chem. Soc.,* 1902, 81, p. 1) showed that this can be almost entirely avoided by replacing the manganese oxide by hydrated ferric oxide, the reaction proceeding according to the equation: 2Fe(OH)3 + 3SO2 = FeS2O6 + FeSO3 + 3H2O. He points ont that the available oxygen in the oxides may react either as SO2 + H2O + = H2SO, or as 2SO2 + H2O + O = H2S2O6; and that in the case of ferric oxide 96% of the theoretical yield of dithionate is obtained, whilst manganese oxide only gives about 75%. A solution of the free acid may be obtained by decomposing the barium salt with dilute sulphuric acid and concentrating the solution *in vacuo* until it attains a density of about 1∙35 (approximately), further concentra­tion leading to its decompositιon into sulphur dioxide and sulphuric acid. The dithionates are all soluble in water and when boiled with hydrochloric acid decompose with evolution of sulphur dioxide and formation of a sulphate. Trithionic acid, H2S3O6, is obtained in the form of its potassium salt by the action of sulphur dioxide on a solution of potassium thiosulphate : 2K2S2O3 + 3SO2 = 2K2S3O6 + S ; or by warming a solution of silver potassium thiosulphate: KAgS2O2 = Ag2S + K2S2O6; whilst the sodium salt may be prepared by adding iodine to a mixture of sodium thiosulphate and sulphite : Na2SO3 + Na2S2O3 + I2 — Na2S3O6 + 2NaI. The salts are un­stable; and a solution of the free acid (obtained by the addition of hydrofluosilicic acid to the potassium salt) on concentration *in vacua* decomposes rapidly: H2S3O6 = H2SO4 + S + SO2. Tetrathionic acid, H2S4O6, is obtained in the form of its barium salt by digesting barium thiosulphate with iodine: 2Ba2S2O2 + I2 — BaS4O6 + 2Bal, the barium iodide formed being removed by alcohol; or in the form of sodium salt by the action of iodine on sodium thiosulphate. The free acid is obtained (in dilute aqueous solution) by the addition of dilute sulphuric acid to an aqueous solution of the barium salt. It is only stable in dilute aqueous solution, for on concentration the acid decomposes with formation of sulphuric acid, sulphur dioxide and sulphur.

Wackenroder’s solution (Debus, *Journ. Chem. Soc.,* 1888, 53, p. 278) is prepared by passing sulphuretted hydrogen gas into a nearly saturated aqueous solution of sulphur dioxide at about 0° C. The solution is then allowed to stand for 48 hours and the process repeated many times until the sulphur dioxide is all decomposed. The reactions taking place are complicated, and the solution contains ultimately small drops of sulphur in suspension, a colloidal sulphur (which Spring *(Rec. trav. chim.,* 1906, 25, p. 253) considers to be a hydrate of sulphur of composition S8∙H2O), sulphuric acid, traces of trithionic acid, tetra-and pentathionic acids and probably hexathionic acid. The solution obtained may be evaporated *in vacuo* until it attains a density of 1∙46 when, if partially saturated with potassium hydroxide and filtered, it yields crystals of potassium pentathionate, K2S5O6∙3H2O. The formation of the pentathionic acid may be represented most simply as follows: 5SO2 + 5H2S = H2S6O6 + 5S + 4H2O. The aqueous solution of the acid is fairly stable at ordinary temperatures. The pentathionates give a brown colour on the addition of ammoniacal solutions of silver nitrate and ultimately a black precipitate. Hexathionic acid, H2S6O6, is probably present in the mother liquors from which potassium pentathionate is prepared. The solution on the addition of ammoniacal silver nitrate behaves simi­larly to that of potassium pentathionate, but differs from it in giving an immediate precipitate of sulphur with ammonia, whereas the solu­tion of the pentathionate only gradually becomes turbid on standing.

The *per-acids* of sulphur were first obtained in 1898 by Caro *(Zeil, angew. Chent.,* 1898, p. 845) who prepared monopersulphuric acid by the action of sulphuric acid on a persulphate. This acid may also be prepared by the electrolysis of concentrated sulphuric acid, and it is distinguishable from persulphuric acid by the fact that it immediately liberates iodine from potassium iodide. It behaves as a strong oxidant and in aqueous solution is slowly hydrolysed. It most probably corresponds to the formula H2SO6.

See H. E. Armstrong and Lowry, *Chem. News* (1902), 85, p. 193; Lowry and West, *Journ. Chem. S'oc.* (1900), 77, p. 950; H. E. Arm­strong and Robertson, *Proc. Roy. Soc.,* 50, p. 105; T. S. Price, *Ber.,* 1902, 35, p. 291 ; *Journ. Chem. Soc.* (1906), p. 53; A. v. Baeyer and V. Villiger, *Ber., passim.*

*Pharmacology.*—The sources of all sulphur preparations used in medicine (except calx sulphurata) are native virgin sulphur and the sulphides of metals. Those contained in the British Pharmacopoeia are the following: (1) *Sulphur sublimatum,* flowers of sulphur (U.S.P.), which is insoluble in water. From it are made *(a) confectio sulphuris ; (&) unguentum sulphuris; (c) sulphur praecipitalum,* milk of sulphur (U.S.P.) which has a sub-preparation *trochiscus sulphuris* each lozenge containing 5 grs. of precipitated sulphur and 1 gr. of potassium acid tartrate; *(d) potassa sulphurata* (liver of sulphur), a mixture of salts of which the chief are sulphides of potassium; (*e*) *sulphuris iodidum* (U.S.P.), which has a preparation *unguentum sulphuris iodidi,* strength 1 in 25. From the heating of native calcium sulphate and carbon is obtained *calx sulphurata* (U.S. and B.P.), or sulphurated lime, a greyish-white powder.

*Therapeutics.—*Externally, sulphur is of use in skin affections. Powdered, it has little effect upon the skin, but in ointment or used by fumigation it has local therapeutic properties. In scabies (itch) it is the best remedy, killing the male parasite, which remains on the surface of the skin. To get at the female and the ova prolonged soaking in soap and water is necessary, the epiderm being rubbed away and the ointment then applied. Precipitated sulphur is also useful in the treatment of acne, but sulphurated lime is more power­ful in acne pustulosa and in the appearance of crops of boils, inter­nally, sulphur is a mild laxative, being converted in the intestine into sulphides. Milk of sulphur, the confection and the lozenge, is used for this purpose. Sulphur and sulphur waters such as those of Harrogate, Aix-la-Chapelle and Aix-les-Bains, have a powerful effect in congested conditions of the liver and intestines, haemor­rhoids, gout and gravel. Sulphur is of use in chronic bronchial affections, ridding the lungs of mucus and relieving cough. In chronic rheumatism sulphur waters taken internally and used as baths are effectual. Sulphur in some part escapes unchanged in the faeces.

When sulphur is burned in air or oxygen, sulphur dioxide is produced, which is a powerful disinfectant, used to fumigate rooms which have been occupied by persons suffering from some infectious disease.

**SULPHURIC ACID,** or Oil of Vitriol, H2SO4, perhaps the most important of all chemicals, both on account of the large quanti­ties made in all industrial countries and of the multifarious uses to which it is put. It is not found in nature in the free state to any extent, and although enormous quantities of its salts, especially calcium and barium sulphate, are found in many localities, the free acid is never prepared from these salts, as it is more easily obtainable in another way, viz. by burning sulphur or a sulphide, and combining the sulphur dioxide thus formed with more oxygen (and water).

Originally prepared by heating alum, green vitriol and other sulphates, and condensing the products of distillation, sulphuric acid, or at least an impure substance containing more or less sulphur trioxide dissolved in water, received considerable at­tention at the hands of the alchemists. The acid so obtained from ferrous sulphate (green vitriol) fumes strongly in moist air, hence its name “fuming sulphuric acid”; another name for the same product is “ Nordhausen sulphuric acid,” on account of the long-continued practice of this process at Nordhausen.

Ordinary sulphuric acid, H2SO4, may be prepared by dissolv­ing sulphur trioxide in water, a reaction accompanied by a great evolution of heat; by the gradual oxidation of an aqueous solution of sulphur dioxide, a fact which probably explains the frequent occurrence of sulphuric acid in the natural waters rising in volcanic districts; or by deflagrating a mixture of sulphur and nitre in large glass bells or jars, absorbing the vapours in water and concentrating the solution. The latter process, which was known to Basil Valentine, was commercially applied by the quack doctor, Joshua Ward (1685-1761), of Twickenham, England, to the manufacture of the acid, which was known as “ oil of vitriol made by the bell ” or *per campanum.* Dr John Roebuck (1718-1794), of Birmingham, replaced the glass vessels by leaden ones, thereby laying the foundation of the modern method of manufacture (see below).

*Properties.—*Pure sulphuric acid, H2SO4, is a colourless, odourless liquid of an oily consistency, and having a specific gravity of 1·8384 at 15°. It boils at 338°, and at about 400° the vapour dissociates into sulphur trioxide and water; at a red heat further decomposition ensues, the sulphur trioxide dis­sociating into the dioxide and water. It freezes to a colourless crystalline mass, melting at 1o∙5°. The acid is extremely hygroscopic, absorbing moisture from the atmosphere with great rapidity; hence it finds considerable application as a desiccating agent. the behaviour of aqueous solutions of sul­phuric acid is very interesting. The pure acid (100% H2SO4) cannot be prepared by boiling down a weaker acid under any pressure (at least between 3 and 300 centimetres of mercury), an acid of the composition H2SO4,1/12H2O or 12SO3, 13H2O being invariably obtained. Neither is there any advantage gained by mixing this hydrate with sulphur trioxide; for when such a mixture is concentrated by evaporation, sulphur trioxide is vaporized until the same hydrate is left. The pure acid, however, may be obtained by strongly cooling this hydrate.