Heilk. Bd. 2. S. 139.) considers it to be endowed with the specific power of influencing secreting surfaces and the bones, whereby it is enabled to ameliorate various morbid conditions of these parts. Sundelin (*Heilmittell.* Bd. 2. S. 234.) regards it as a stimulant and tonic to the sexual organs. Various effects have been ascribed to it by Herder. (*Hufeland's Journ.* Bd. 9. St. 3. S. 148.)

USES.—Phosphoric acid has been employed in the same cases in which sulphuric and other mineral acids have been used, and under the same regulations. It may be employed for a longer period, without disturbing the digestive functions, than the other agents of this class.

It has been used in certain cases rather on theoretical than practical grounds. Thus its power of dissolving phosphate of lime has led to its employment in those forms of lithiasis attended with phosphatic deposites in the urine,—in ossification of the arteries and cardiac valves,—and in exostosis and other osseous tumours. Lentin used it as a local agent to check caries, from a notion that this disease depends on a deficiency of phosphoric acid in the part affected. Woulff applied it to promote the formation of bone.

There are several other diseases against which this acid has been administered. Thus it has been given in blennorrhœa and leucorrhœa, when the secreted fluid was thin and acrid (Sundelin,)—in profuse suppuration, to diminish the quantity and improve the quality of the secreted matter,—in hysterical affections of young and irritable subjects, Sundelin has found it useful,—in impotency of the male (Berends,)—in diabetes, and in jaundice. Dr. Paris (*Appendix to the 8th ed. of the Pharmacologia.* Lond. 1836.) has found it to assuage the thirst so commonly present in diabetes, more effectually than any other acidulated drink.

ADMINISTRATION.—Internally the dilute phosphoric acid should be given in doses of from ten minims to a fluid-drachm, properly diluted. Mixed with eight or ten times its volume of water, it may be employed as a wash in caries.

ANTIDOTE.—(See *Sulphuric Acid.*)

ORDER X. SULPHUR AND ITS NON-METALLIC COMPOUNDS.

1. SUL'PHUR, *L. E.*—SULPHUR OR BRIMSTONE.

HISTORY.—Sulphur has been known from the most remote periods of antiquity. It is mentioned by Moses, (*Genesis*, xix. 24.) Homer, (*Iliad*, lib. xvi.) and other ancient writers.

NATURAL HISTORY.—It is found in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—*Native* or *virgin sulphur* occurs in two forms: either imbedded in rocks (*common native sulphur,*) or produced by sublimation (*volcanic sulphur.*) In Sicily[1] it is found in beds in a blue clay formation, which, in the opinion of Dr. Daubeny, is more recent than chalk, but is of the same age with the gypsum beds in the neighbourhood of Paris. Solfatara (called by the ancients *Forum Vulcani* or the *Court of Vulcan,*) a kind of half-extinct volcano, in the vicinity of Naples, is celebrated for its native sulphur, which is collected in considerable quantities for the purpose of commerce. (Sir W. Hamilton, *Compi Phlegræi*, 1776.) Sulphur is also found in the mineral kingdom in a state of combination. Thus sulphurous acid gas rushes out from volcanoes. Sulphuric acid is found native both in the free and combined states: hydrosulphuric acid gas is evolved from the pure sulphurous or hepatic waters (see p. 249,) and from the soil in some other places: lastly, sulphur is found in combination with metals. Dr. Thomson (*Outlines of Mineralogy*, &c. vol. i. p. 76.) mentions fourteen native sulphurets and seventeen sulphur salts.

β. IN THE ORGANIZED KIDGDOM.—Sulphur is found in *Liliaceæ* (as in garlic:) in *Cruciferæ* (as in mustard:) in *Umbelliferæ* (as in asafœtida,) and in many other orders of plants. The alkaline and earthy sulphates are frequently met with in vegetables. Sulphur is also a constituent of some animal substances (thus it is found in eggs, urine, &c.;) sulphates are found in the urine.

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[1] Some mineralogists entertain the opinion that Sicilian sulphur is of organic (animal) origin. See *Athenæum* for December 1st, 1838; also Leonhard, *Handbuch der Oryktognosie*, S. 599. Heidelberg, 1826.

Preparation.—Sulphur is procured in two ways; by the purification of native sulphur, or by the decomposition of the native sulphurets. The sulphur of British commerce is almost exclusively obtained in the first way. It is brought principally from Italy and Sicily. During the year 1830 no less than 236,338 cwts. of rough brimstone were imported from Italy and the Italian islands. (*Parliam. Ret.* 367, ordered to be printed, April, 1832.)

α. Purification of native sulphur.—In Sicily, from whence most of this substance is procured, the native sulphur is submitted to a rude process of fusion: it is collected in heaps, which are set fire to on the surface: the heat developed by the combustion of one portion fuses another. (Daubeny, *Description of Volcanoes*, p. 197.)

Another mode of purifying native sulphur is to distil it in earthen pots. These are arranged in two rows in a large oblong furnace, the top of each pot, which serves for the introduction of the sulphur and for the removal of the residuum, being kept closed during the operation. The upper and lateral part of each pot communicates with an inclined tube of about two inches diameter and fourteen long. When the fire is lighted in the furnace, the sulphur fuses and sublimes, and passes through this tube into another pot, placed on the outside of the furnace, and perforated near its bottom to allow the melted sulphur to flow into a pail containing water, where it congeals, and forms the rough or crude sulphur (*sulphur crudum.*) (Dumas, *Traité de Chimie*, t. 1er. p. 121.)

Crude sulphur is purified in this country. The process formerly adopted was to submit it to fusion in an iron cauldron: the earthy impurities subsided, and the liquid sulphur was ladled out and cast in moulds. The improved method of purification is to submit it to distillation in an iron still.

For this purpose crude sulphur is put into an iron pot, set in brickwork, over a proper fire. To this is adapted an iron head removeable by a crane, and communicating by two tubes or necks, the one with the sulphur chamber, the other with the iron receiver, which is immersed in water. The communication between the still and the receiver being shut off, the sulphur distils into the sulphur chamber, on the walls of which it is deposited in a pulverulent form. When obtained in this state it is called *Flowers of Sulphur.* The door into this chamber is placed near the ground, and is closed when the process is going on. If the communication between the still and the sulphur chamber be shut off by turning the handle, and the communication between the still and the receiver opened, the sulphur distils over and condenses into a liquid which, when solidified, constitutes the *refined Sulphur* of commerce. The elbow-pipe which forms the communication between the still and the receiver, is encased in a metal jacket, between which and the tube a current of cold water is continually flowing from the butt, and, after passing around the receiver, escapes, by a cock. The top of the receiver is perforated by a vent pipe, and is supplied with a circular aperture (by which the liquid sulphur can be ladled out,) usually kept closed by a moveable lid.

The *Stick, Roll,* or *Cane Sulphur* (*Sulphur in baculis; Sulphur in rotulis; Sulphur rotundum*) is refined sulphur which has been cast in wooden moulds.

"*Sublimed Sulphur* (*Sulphur sublimatum*, L. D.,) commonly termed *Flowers of Sulphur* (*Flores Sulphuris*,) is apt to be contaminated with a little adhering acid (formed by oxidation of sulphur,) which, in both the Edinburgh and Dublin pharmacopœias, is ordered to be removed by washing. [For this the U. S. Pharmacopœia simply uses the word *Sulphur*, when unwashed, and *Sulphur Lotum* when washed.]

The Edinburgh College orders *Sulphur sublimatum* to be thus prepared:—

"Sublime sulphur in a proper vessel; wash the powder thus obtained with boiling water in successive portions till the water ceases to have an acrid taste; then dry the sulphur with a gentle heat.

The *Sulphur lotum* of the Dublin Pharmacopœia is prepared by pouring hot water on sublimed sulphur, and repeating the washing so long as the effused water appears contaminated with acid. This is discoverable by means of litmus. The sulphur is then to be dried on bibulous paper.

β. *Decomposition of Metallic Sulphurets.*—In some places sulphur is procured by the decomposition of metallic sulphurets (of iron and copper.) In Anglesea, it is (or was) prepared by roasting copper pyrites, by which part of the sulphur is burned, while the remainder is volatilized and collected in chambers connected with the domes of the furnaces by means of horizontal flues. (Atkin's *Dict. of Chem.* vol. ii.)

The dregs remaining after the purification of sulphur are called *Horse Brimstone Sulphur vivum;* (*Sulphur caballinum; Sulphur griseum.*)

Properties.—At common temperature, pure sulphur is a brittle, crystallizable solid, of a yellowish-green colour, without smell, and with a very weak and almost imperceptible taste. Its specific gravity is about 1·99, but, when free from air-bubbles, 2·087. It is a bad conductor of electricity; and, therefore, by friction becomes powerfully electric. It is a bad conductor of heat, and when grasped in the warm hand, crackles, and sometimes breaks to pieces. It is fusible, volatilizable, and combustible. In atmospheric air it burns with a pale blue flame, and emits a large quantity of fumes having a peculiar suffocating odour (*sulphurous acid.*)

It is called *dimorphous*, because it is capable of crystallizing in forms belonging to two systems of crystallization. Thus, crystals of native sulphur, and those deposited from solutions of sulphur, belong to the right prismatic system; while crystals obtained by fusion and slow cooling of sulphur are referrible to the oblique rhombic prismatic system. It is temperature which determines the form: crystals which are formed at a temperature below 232°, belong to the right prismatic system; on the other hand, those produced at 232°, belong to the oblique system.

When sulphur is heated to 340°, it becomes viscid; and, by increasing the heat, the viscidity increases, until the temperature arrives at between 400° and 500°. If, while in this state, it be suddenly cooled, as by throwing it into water, it remains quite soft, so that it may be drawn out into threads. The cause of this change, which seems to be merely physical, is not understood. The atomic weight of sulphur is about 16.

Characteristics.—Sulphur is easily distinguished from other bodies, by its colour, its fusibility, its volatility, and its burning with a blue flame, and the evolution of sulphurous acid gas, the odour of which can be easily recognised.

Impurities.—Rough sulphur is always mixed with variable quantities of foreign substances. Vauquelin (*Ann. de Chim.* 25, 50.) distilled 200 grains, and obtained a residuum of 0·82, composed of silica, carbonate of lime, iron, bituminous charcoal, alumina, and magnesia, but the proportion of earthy matters is generally more considerable. Sulphur obtained from pyrites sometimes contains orpiment (*sesquisulphuret of arsenicum.*) The purity of any specimen is determinable by dissolving it in oil of turpentine, which does not act on the foreign matters. It should be perfectly volatile.

At a temperature of 600° sublimed sulphur totally evaporates. When washed with water, it does not alter the colour of litmus. *Ph. Lond.*

Litmus detects the presence of any free acid (sulphurous or sulphuric acid.)

Physiological Effects. α. *On Vegetables.*—Sulphur does not appear to be injurious to vegetables, for seeds vegetate and produce thriving plants when sown in sulphur.

β. *On Animals.*—At the veterinary school of Lyons it was found that a pound of sulphur killed horses by producing violent inflammation, recognisable during life by the symptoms, and after death by the morbid appearance. (Christison's *Treatise on Poisons.*)

γ. *On Man.*—In *small* and *repeated doses* sulphur acts as a gentle stimulant to the secreting organs, especially to the skin and the mucous membranes, particularly the bronchial membrane. It promotes the capillary circulation of these parts, and increases their secretions. Sundelin (*Heilmittell.* Bd. 1, S. 196.) says it operates specifically on the mucous membrane of the rectum, and thereby promotes critical hemorrhoidal secretions. That it becomes absorbed is shown by the odour of hydrosulphuric acid which it communicates to the sweat, urine, and milk, and by silver articles becoming blackened in the pockets of patients who are under the influence of it. By the German physicians it is called a resolvent, and is ranked with the mercurial and antimonial preparations. (See p. 194.) "From mercurial and antimonial medicines," says Sundelin, "sulphur is distinguished by its great diffusibility: in virtue of which it approximates to the exciting tonic agents; and also by its not possessing the liquefacient properties of these agents."

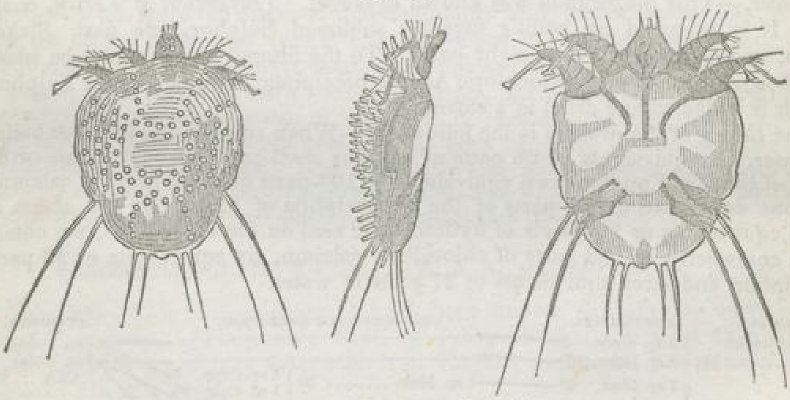
In *larger doses* (as one or two drachms) sulphur acts as a mild purgative, without exciting the pulse or occasioning griping. As the stools are usually solid, Dr. Paris (*Pharmacologia*, vol. i. art. *Cathartics.*) concludes that the action of sulphur on the bowels is confined to the muscular coat.

Uses.—Sulphur is employed both internally and externally.

α. *Internally.*—It is given for various purposes. *In affections of the rectum*, as stricture, hemorrhoids, and prolapsus, it is a valuable agent as a mild purgative. I have frequently employed it in these cases as a substitute for castor oil. In order to promote its purgative effect, it will be sometimes necessary to conjoin magnesia or the bitartrate of potash. *In chronic cutaneous diseases*, more especially prurigo, impetigo, and scabies, the internal use of sulphur is sometimes attended with great benefit. *In pulmonary affections*, as chronic catarrhs and asthma, it is said to be sometimes useful. *In rheumatic and gouty affections* also. After an attack of acute rheumatism, when the joints are left in a swollen and painful state, I have seen sulphur prove highly useful. It is popularly taken with ardent spirit in this complaint. It has been employed as an *anthelmintic*. Vogt employs it as a *resolvent* in inflammation: as in croup, bronchitis, peripneumonia, and abdominal inflammation. In some constitutional diseases (as scrofula and secondary syphilis) it has been used as an *alterative*. Tortual has proposed sulphur as a preservative against measles: but, as might be expected, experience shows sulphur possesses no prophylactic power of this kind, and that the only preservative is isolation.

β. *Externally.*—Sulphur is a most valuable remedy in various skin diseases, more especially *scabies;* and notwithstanding many substitutes have been proposed for it in the latter disease, none are so generally successful. It is supposed by some that its curative powers in this disease depend on its poisonous influ-

Fig. 58.



Sarcoptes Hominis—(Raspail.)

ence over the so-called *itch-insect* (*Sarcoptes Hominis* of Raspail, the *Acarus Scabiei* of other writers:) a little parasite belonging to the class *Arachnida* or articulated animals, and, therefore, improperly termed an *insect*. (Raspail, *Mémoire sur l'Insect de la Gale*. Paris, 1834.)

But before adopting this explanation of the *modus medendi* of sulphur, it is to be proved that the animal is the *cause* of the disease; for, at present, it has not been satisfactorily shown whether it be the cause, effect, or mere accompaniment of itch. Rayer (*Treatise on Diseases of the Skin*, by Dr. Willis, p. 344.) observes, that it is indubitable that the number of these insects bears no proportion to that of the vesicles. "It is, farther," he adds, "rare to discover these insects on the abdomen and on groins, where the eruption of scabies is nevertheless very common and very apparent; moreover, scabies is known to continue when no more acari are to be discovered." Sulphur is also a most valuable application in various other skin diseases, as porrigo, impetigo, &c.

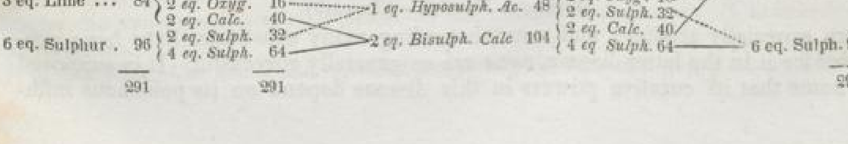
ADMINISTRATION.—Internally, it is usually given with syrup, or treacle, in the form of an electuary, or suspended in milk. The dose of it, as a purgative, is from one to three or four drachms. As an alterative and sudorific, the dose is about half a drachm.

1. UNGUENTUM SULPHURIS, L. E. D. (U. S.) *Sulphur or Brimstone Ointment.* (Sulphur [sublimed] ℥iij. [℥j., *E.*; lbj., *D.*;] Hog's lard, lbss. [℥iv., *E.*; lbiv., *D.*] Mix them thoroughly together.—The *London College* adds of Oil of Bergamot, ♏xx.) [Sulphur a pound, Lard two pounds, U. S.] Extensively employed in scabies, porrigo, and other skin diseases. In scabies, it is to be applied every night until the disease is cured.

2. UNGUENTUM SULPHURIS COMPOSITUM, *L. Compound Sulphur Ointment.*—(Sulphur, lbss.; White Hellebore, powdered, ℥ij.; Nitrate of Potash, ʒj.; Soft Soap, lbss.; Lard, lbjss.; Oil of Bergamot, ♏xxx. Mix.) This is employed in the same cases as the preceding preparation, than which it is considered more efficacious, but at the same time more irritating. [The Ointment directed by the U. S. Pharmacopœia by this name is different from the preceding, though used for the same purposes; the formula is the following:—Take of Sulphur an ounce; Ammoniated Mercury, Benzoic Acid, each a drachm; Oil of Bergamot, Sulphuric Acid, each a fluid-drachm; Nitrate of Potassa two drachms; Lard half a pound. To the Lard, previously melted with a moderate heat, add the other ingredients and stir them constantly until they are cold.]

3. SULPHUR PRÆCIPITATUM; *Precipitated Sulphur; Lac Sulphuris* or *Milk of Sulphur.*—This preparation was known to Geber. (*Invention of Verity*, chap. vi.) It is prepared by boiling together sublimed Sulphur, one part; Slaked Lime, two parts; and Water eight parts. To the filtered solution is to be added a sufficient quantity of Hydrochloric Acid to precipitate the whole of the Sulphur, which is collected and dried in a stove.

The *theory* of the process is the following:—When sulphur and lime are boiled in water, six equivalents or 96 parts of sulphur react on three equivalents or 84 parts of lime, and produce two equivalents or 104 parts of bisulphuret of calcium, and one equivalent or 76 parts of the hyposulphite of lime. By the action of three equivalents or 111 parts of hydrochloric acid on these two salts, we obtain three equivalents or 168 parts of chloride of calcium, six equivalents or 96 parts of sulphur, and three equivalents or 27 parts of water.



Precipitated sulphur agrees in most of its properties with sublimed sulphur, but is much whiter, and is in a finely pulverulent form. Berzelius says, that when melted, it gives out a little sulphuretted hydrogen; and on cooling, resumes the yellow colour it had before it was boiled with the alkali. H. Rose (Poggendorf's *Annalen*, xlvii.; also, *Pharm. Central-Blatt. für* 1839, S. 441.) ascribes the whiteness of precipitated sulphur to its containing sulphuretted hydrogen in the state of persulphuret of hydrogen.

It is composed of sulphur with a little water; and hence it is frequently termed *hydrate of sulphur.* According to Bucholz, however, when well dried, it contains hardly a trace of water, and, therefore, that which, under ordinary circumstances, is contained in it, must be regarded as hygroscopic; so that the term *hydrate* is not strictly applicable to it.

On account of the extensive adulteration of this preparation, it has been omitted from all the British pharmacopœias. In the preparation of nearly the whole of the precipitated sulphur of the shops, sulphuric acid is substituted for hydrochloric acid, by which the product contains about two-thirds of its weight of sulphate of lime. Mr. Schweitzer (*British Annals of Medicine*, vol. i. p. 618.) analyzed a sample, and found its composition to be as follows:—

Sulphate of Lime	50
Water of Crystallization of ditto	13·1
Sulphur	36·9
Lac Sulphuris of the shops	100·0

I was informed by an extensive manufacturer of this article, that he prepares both kinds, the pure and the adulterated, and that the firm of Messrs. Barry & Co. is almost the only one which buys the pure kind. The adulteration is readily detected by subjecting the suspected preparation to heat in a crucible or on a fire shovel, when the sulphur and water of crystallization are volatilized, leaving behind the sulphate of lime. Or the sulphur may be dissolved out by oil of turpentine or liquor potassæ.

The effects, uses, and doses of this preparation, are the same as those of sublimed sulphur.

4. **OLEUM SULPHURATUM**; *Sulphurated Oil; Balsamum Sulphuris*, or *Balsam of Sulphur.* In the London Pharmacopœia for 1824, this compound was ordered to be prepared by dissolving one part of Sublimed Sulphur in eight parts of Olive Oil. The compound thus procured cannot be regarded as a mere solution of sulphur in oil, since the odour of hydrosulphuric acid, which it possesses, proves that the oil has undergone partial decomposition: in fact, the heat to which the oil is raised in order to boil it, causes a chemical change.

It is a dark reddish-brown viscid substance, having an extremely unpleasant odour. Its local action is that of an acrid: its remote operation that of a stimulant, causing thirst and febrile heat. It has been supposed to possess expectorant and diaphoretic properties. It is applied to foul ulcers, and is employed internally in chronic pulmonary affections. The dose of it is from 40 to 50 drops: but its unpleasant taste and smell almost precludes its use.

2. AC'IDUM SULPHU'RICUM, *L. E. D.* (U. S.)—SULPHURIC ACID.

History.—This acid appears to have been known to Geber as early as the seventh century. (Thomson's *Syst. of Inorg. Chem.* vol. ii. p. 29.) In the state in which we usually meet with it in English commerce, it is usually denominated *Oil of Vitriol.*

Natural History.—It is found in both kingdoms of nature.

Fig. 59.

Cascade of Vinagre in Colombia.

α. In the Inorganized Kingdom.—It is found in the waters of some volcanic regions, and is evidently produced by the combustion of sulphur. The *Rio Vinagre*, (Vinegar River,) which descends from the volcano of Puracé, in Colombia, to Popayan, has received its name from its acid properties, which it derives from being impregnated with sulphuric and hydrochloric acids. (A. de Humboldt, *Vues des Cordillères*, p. 220.)

Issuing from the crater of Mont Ida, in Java, is a river which also contains this acid. Dr. Thomas Thomson (*Mineralogy*, vol. i. p. 75.) states, that in Persia there is an earth so strongly impregnated with it, that it is used by the natives as an acidulous seasoner of food. This author also says, (*Op. cit.* p. 77.) that there are no less than twenty-seven sulphates (consisting of combinations of sulphuric acid with one or more bases) in the mineral kingdom. The most abundant of these is the sulphate of lime. The *Sour Springs* of Byron, Genesse county, ten miles south of the Erie canal, contain pure sulphuric acid. (Eaton, *Quarterly Journal of Science*, 1829, p. 200.)

β. In the Organized Kingdom.—The sulphates of lime, potash, and soda, have been found in plants. (De Candolle, *Phys. Végét.* p. 390.) The sulphates of potash and soda are mentioned by Berzelius (*Traité de Chim.* t. 7^{me}, p. 393.) as constituents of human urine.

Preparation.—The most improved method of manufacturing oil of vitriol adopted in this country, is the following:—Crude sulphur is burned on a stone hearth or iron plate in a furnace (or *burner*,) and the gas (sulphurous acid) thereby produced, is conveyed by a pipe or chimney into a leaden chamber, the bottom of which is covered to the extent of four or five inches with water. The furnace door has two apertures to regulate the supply of atmospheric air. After combustion has continued for several hours, an iron pot or pan, containing a mixture of the nitrate of potash or soda and oil of vitriol, is introduced into the furnace, and steam is conveyed into the leaden chamber.[1] So that sulphurous acid, nitric or nitrous acid (generated by the action of the oil of vitriol on the nitrate of potash, and volatilized by the heat produced by the combustion of the sulphur,) and steam, are conveyed into the leaden chamber, and by their mutual reaction produce sulphuric acid, which is absorbed by the water at the bottom of the chamber. To prevent loss in the process, the residual gases are conveyed through two or more leaden chambers of unequal size (also containing water) before they are allowed to escape into the air. In one manufactory which I inspected, the chambers communicated with each other through a double-necked stone bottle, at the bottom of which was water.

The leaden chamber is sometimes divided into two or three compartments by leaden curtains placed across it, as shown in the following cut taken from Professor Graham's *Elements of Chemistry*, vol. i. p. 324.

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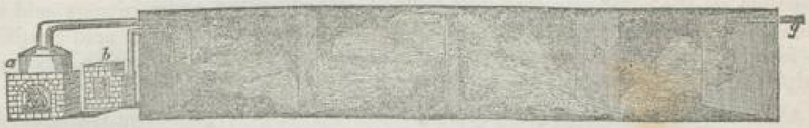
[1] Mr. Graham states, that sulphurous acid, nitric acid vapour, and steam, are simultaneously admitted into the leaden chamber.

FIG. 60.



Oil of Vitriol Chamber.

a. Steam Boiler.
b. Section of Furnace or Burner.
d. and *f*. Leaden curtains suspended from the roof of the chamber to within 6 inches of the floor.
e. Leaden curtain rising from the floor to within 6 inches of the roof.
g. Leaden conduit or vent tube for the discharge of uncondensible gases. It should communicate with a tall chimney to carry off these gases, and to occasion a slight draught in the chimney.

These curtains "serve to detain the vapours, and cause them to advance in a gradual manner through the chamber, so that the sulphuric acid is deposited as completely as possible, before the vapours reach the discharge tube."

To check the combustion of the sulphur, it is sometimes mixed with some earthy matter, and made into truncated pyramidal masses, which are burnt in the usual way.

Since the high price of native sulphur, manufacturers have employed iron pyrites to yield sulphuric acid. I have seen pyrites from Wicklow, Cornwall, and St. Lucia, used for this purpose. The furnace for the combustion of it requires bars, to allow a greater supply of air. The sulphuric acid obtained from pyrites is usually contaminated with arsenious acid.

At Mr. Farmer's oil of vitriol manufactory, Kennington Common, I witnessed the escape of brown vapour (nitrous acid) from the vent pipe of the leaden chamber; and I was informed this was usual. It is evident, therefore, that the nitric acid is not completely deoxidized.

A crystalline matter is sometimes deposited in the pipes connected with the leaden chambers. It indicates a deficiency of water in the process. When the liquid in the leaden chamber has acquired a sp. gr. of about 1·5 (1·6 or 1·7, according to Mr. Farmer's statement to me,) it is conveyed by leaden pipes into rectangular leaden boilers, where it is evaporated and concentrated until its sp. gr. is 1·70 (1·75, Farmer;) but in some manufactories this part of the process is omitted. The final concentration is effected by boiling it down in *glass or platinum retorts:* the latter, notwithstanding their great cost, are now usually adopted. Their price, of course, depends on their size. Mr. Parkes (*Chem. Essays*, vol. i. p. 535.) had one which held thirty gallons, and cost about £360; but sometimes they are made so large, that they are worth £1000 each. In this apparatus the acid is deprived of a part of its water and some sulphurous acid, and when it has attained a sufficient degree of concentration, it is drawn off by means of a platinum syphon into carboys.

The *theory* of the process is the following:—When sulphurous acid gas, nitric acid vapour, and aqueous vapour, come into contact with each other, the sulphurous acid robs the nitric acid of part of its oxygen, and is thereby converted into sulphuric acid. By this partial deoxidation, nitric acid is converted into nitrous acid.

MATERIALS.			PRODUCTS.
1 eq. Nitric Acid	54	1 eq. *Nitrous Acid.* 46 1 eq. *Oxygen*...... 8	1 eq. Nitrous Acid 46
1 eq. Sulphurous Acid..	32		1 eq. Sulphuric Acid...... 40
	86		86

The nitrous acid thus produced is farther deoxidized and converted into binoxide of nitrogen, by another portion of sulphurous acid, which, thus gaining oxygen, is converted into sulphuric acid. If there be excess of nitrous acid and a deficiency of water, a crystalline matter[1] is sometimes deposited. Its formation depends on the sulphuric acid first formed, decomposing some nitrous acid into nitric acid and binoxide of nitrogen: with the latter the sulphuric acid combines to form the crystalline compound. Hence to prevent its production excess of sulphurous acid and water should be present.

An interesting illustration of the above reactions is obtained by generating sulphurous acid in a flask, and conveying the gas, by means of a curved glass tube, into a tall jar, at the bottom of which is a small quantity of colourless but concentrated nitric acid. Brown vapours of nitrous acid are evolved, sulphuric acid is formed, and the jar becomes lined with a crystalline matter, which dissolves with effervescence in water.

The old method of manufacturing oil of vitriol, and, indeed, one still followed in some places, consists in burning a mixture of eight parts of sulphur and one part of nitrate of potash (or nitrate of soda) on iron or leaden plates, either within the leaden chamber or in a furnace on the outside of it. (Parkes's *Chemical Essays*, vol. i. 465.)

In this process an equivalent of sulphur combines with two equivalents of atmospheric oxygen to form one equivalent of sulphurous acid. Another equivalent of sulphur abstracts three equivalents of oxygen from one equivalent of nitric acid of the nitrate, and thereby becomes sulphuric acid, which, with the potash of the nitre, forms an equivalent of sulphate of potash. One equivalent of binoxide of nitrogen is evolved by the decomposed nitric acid, and this, combining with two equivalents of atmospheric oxygen, becomes nitrous acid, which, aided by the presence of water, reacts on a farther portion of sulphurous acid.

At Goslar, Nordhausen, and other parts of Saxony, sulphuric acid is made thus:—Crystallized sulphate of iron is calcined, by which the greater portion of its water of crystallization is expelled. It is then distilled in earthen vessels, by which *fuming sulphuric acid* is procured, while sesquioxide of iron is left in the retort. If this acid be heated in a glass retort, real or anhydrous sulphuric acid distils over.

PROPERTIES. α. **Of Anhydrous Sulphuric Acid.**—It is a white crystalline solid, having very much the appearance of asbestos. Exposed to the air it attracts water, and flies off in the form of dense white fumes. It melts at 66° F., and boils at from 104° to 122° F. The sp. gr. of the liquid acid, at 78° F. is 1·97. It does not redden litmus unless moisture be present.

Its composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Berzelius.*		*Vol.*
Sulphur	1	16	40	40·14	Sulphurous acid gas	1
Oxygen	3	24	60	59·86	Oxygen gas	0·5
Anhydrous Sulphuric acid.	1	40	100	100·00	Sulphuric acid vapour	1?

β. **Of Nordhausen or Fuming Sulphuric Acid.**—This is usually a dark-brown, oily liquid, which gives out copious white fumes in the air. Its sp. gr. is about 1·9. It is imported in stone bottles, having a stoneware screw for a stopper. When subjected to heat, it gives out the vapour of anhydrous sulphuric acid: the residue in the retort resembles oil of vitriol. The composition of fuming sulphuric acid is as follows:—

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[1] Much difference of opinion has existed with respect to the nature of the crystalline matter which is occasionally formed in the leaden chamber of the sulphuric acid manufacturer. Davy (*Elements of Chemical Philosophy*, p. 276, 1812) regarded it as a compound of *water*, *nitrous acid*, and *sulphurous acid*. Dr. W. Henry (*Annals of Philosophy*, N. S. xi. p. 368.) and afterwards Gaultier de Claubry (*Ann. de Chim. et Phys.* t. xlv. p. 284) submitted it to analysis. The latter found its constituents to be *anhydrous sulphuric acid* 65·59, *hyponitrous acid* 23·96, and *water* 10·10. In 1839 Henrich Rose (*Pharm. Central-Blatt für* 1839, S. 664) described a solid compound of *anhydrous sulphuric acid* and *binoxide of nitrogen* ($2SO^3 + NO^2$) Adolphe Rose (Ibid. *für* 1840, S 481; also *Journ. de Pharm.* t. xxvii. p. 138) has shown that the crystals which form in the leaden chamber consist of *sulphuric acid*, *binoxide of nitrogen*, and *water*. M. Provostaye (*Journ. de Pharm.* t. xxvi. p. 637) has also examined this crystalline matter.

	Atoms.	*Eq. Wt.*	*Per Ct.*			*Atoms.*	*Eq. Wt.*
Anhydrous Sulphuric Acid	2	80	89·88	or	Anhydrous Sulphuric Acid	1	40
Water	1	9	10·11		Protohydrate Sulphuric Acid	1	49
Fuming Sulphuric Acid	1	89	99·99			1	89

γ. **Of Oil of Vitriol, or English Sulphuric Acid.** (*Acidum Sulphuricum*, L. E. (U. S.) *Acidum Sulphuricum venale*, D.)—This is a colourless, transparent, inodorous, highly acrid, and corrosive liquid. It possesses the usual properties of a powerful mineral acid in a very eminent degree, such as reddening the vegetable blues, saturating bases, and displacing other acids. Its affinity for water is most intense, and by virtue of this, it absorbs aqueous vapour from the atmosphere, and chars animal and vegetable substances. When mixed with water there is a mutual condensation with the evolution of heat. Various substances when heated in sulphuric acid decompose it; they abstract oxygen and evolve sulphurous acid. This is the case with charcoal, organic substances, phosphorus, sulphur, and several of the metals, as copper, tin, and mercury.

The sp. gr. of this acid at 60° F. is about 184. Genuine *commercial* acid should never surpass 1·8455; when it is denser, we may infer sophistication or negligence in the manufacture. (Brande's *Manual of Chemistry*, 5th edit. 1841.)

According to the *London College*, good oil of vitriol possesses the following characters:—

It is free from colour. Its specific gravity is 1·845. What remains after the acid has been distilled to dryness, does not exceed the four-hundredth part of its weight. Diluted sulphuric acid is scarcely coloured by hydrosulphuric acid.

The *Edinburgh College* gives the following characters of it:—

"Density 1840, or near it: colourless: when diluted with its own volume of water only a scanty muddiness arises, and no orange fumes escape."

The "muddiness" here referred to depends on the precipitation of sulphate of lead, which commercial oil of vitriol usually holds in solution, but which is deposited when water is added. The "orange fumes" are nitrous acid vapour.

The *Dublin College* states the sp. gr. of commercial sulphuric acid to be 1·850; but this is erroneous. It ought not to exceed 1·845.

In order to procure *Pure Oil of Vitriol* (*Acidum Sulphuricum purum*, E. D.,) both the Edinburgh and Dublin Colleges give directions for the purification of the commercial acid.

The *Edinburgh College* states, that "if commercial sulphuric acid contain nitrous acid, heat eight fluid ounces of it with between ten and fifteen grains of sugar, at a temperature not quite sufficient to boil the acid, till the dark colour at first produced shall have nearly or altogether disappeared. This process removes nitrous acid. Other impurities may be removed by distillation; which, on the small scale, is easily managed by boiling the acid with a few platinum chips in a glass retort by means of a sand-bath or gas-flame,—rejecting the first half ounce." The College gives the following characters of the pure acid:—"Density, 1·845: colourless: dilution causes no muddiness: solution of sulphate of iron shows no reddening at the line of contact when poured over it."

The *Dublin College* orders of Commercial Sulphuric Acid, lbj. Pass the acid into a retort of flint glass, attach a receiver of the same kind, and with the junctures of the vessels left open, let heat be applied to the retort until one-twelfth part of the liquor shall have distilled over; this, as it contains water, should be rejected. The receiver being again applied, the residuum is to be redistilled to dryness. A few slips of platina passed into the acid in the retort will restrain the ebullition, which otherwise would be too violent. The specific gravity of this acid is to the specific gravity of distilled water as 1·845 to 1·000. Let this acid be kept in well-closed vessels.

COMPOSITION.—The composition of oil of vitriol or English sulphuric acid is as follows:—

	Strongest (sp. gr. 1·845.)			Commercial (sp. gr. 1·8433.)		
	Atoms.	*Eq. Wt.*	*Per Cent.*	*Atoms.*	*Eq. Wt.*	*Per Cent.*
Real sulphuric acid	1	40	81·6	1	40	78
Water	1	9	18·4	1¼	11·25	22
Oil of Vitriol	1	49	100·0	1	51·25	100

Characteristics.—Free sulphuric acid or the soluble sulphates are recognised by a solution of any of the barytic salts, which throws down a heavy white precipitate (*sulphate of baryta*) insoluble in acids or alkalis. If this precipitate be ignited with charcoal, it is decomposed and converted into sulphuret of barium, which, on the addition of hydrochloric acid, evolves hydrosulphuric acid, known by its odour and its blackening paper moistened with acetate of lead. If sulphuric acid be heated with organic matter, sulphurous acid is given out: this may be known by its odour, and by its occasioning the formation of the blue iodide of starch, when mixed with iodic acid and starch. Oil of vitriol is reddened by veratria, salicin, piperin, oil of bitter almonds, phloridzine, &c.

To determine whether sulphuric acid be free or combined with a base, Dr. Christison (*Treatise on Poisons*, 3d ed. p. 142.) recommends the liquid to be boiled with pure carbonate of lead. If free sulphuric acid be present, sulphate of lead will be formed, which, being insoluble in dilute nitric acid, may be thereby distinguished from carbonate of lead; and it is assumed that no sulphate of lead will be formed if there is only a natural sulphate present, "because carbonate of lead and the neutral sulphates do not decompose each other." But this test is liable to objection: alum, sal enixum, sesquisulphate of iron, and other supersulphates, react on carbonate of lead like free sulphuric acid; and, farthermore, neutral sulphate of ammonia is decomposed at a boiling temperature by carbonate of lead.

IMPURITIES.—Pure oil of vitriol should be colourless: the presence of *organic matter*, as cork, communicates a brownish or black colour. The acid of commerce usually contains traces of *sulphate of lead:* this may be detected either by adding water, when the white sulphate is precipitated; or by the addition of hydrosulphuric acid to the dilute sulphuric acid, when a very slight change of colour is observed, owing to the formation of sulphuret of lead. "What remains [*i. e.* sulphate of lead] after the acid has been distilled to dryness does not exceed the $\frac{1}{400}$ part of its weight."

Oil of vitriol frequently, or usually, contains an *oxide of nitrogen*. According to A. Rose it is generally the binoxide of nitrogen. A solution of the protosulphate of iron detects the binoxide of nitrogen, nitrous acid, or nitric acid, by the reddish brown or brownish black colour which it gives rise to, "if a sufficient quantity of pure sulphuric acid be added to the liquid to be examined" (A. Rose.) Permanganate of potash is an excellent test of binoxide of nitrogen or nitrous acid in sulphuric acid, diluted with about six parts of water. If either of these substances be present, the permanganate is decolourized. The effect is not produced by the presence of pure nitric acid in diluted sulphuric acid. Hence it distinguishes binoxide of nitrogen and nitrous acid from nitric acid.

Latterly, in consequence of the high price of Sicilian sulphur, sulphuric acid has been extensively manufactured from iron pyrites, in which arsenic is usually contained; and in consequence the oil of vitriol of commerce has been found to be contaminated with *arsenious acid*. Dr. G. O. Rees (*London Medical Gazette* for Feb. 5, 1841.) found 22·58 grains of this acid in twenty fluid ounces of oil of vitriol; and Mr. Watson[1] states that the smallest quantity which he has detected is 35½ grains in twenty fluid ounces. The tests for this dangerous contamination are Marsh's test and sulphuretted hydrogen.[2] In the application of these the acid must be previously diluted with distilled water.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—In the concentrated state sulphu-

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[1] *London Medical Gazette* for Feb. 1841. Mr. Watson states that a man had nearly lost his life in consequence of the inhalation of arseniuretted hydrogen, produced in the manufacture of hydrochloric acid, by the diluted, unpurified, pyrites sulphuric acid acting upon the iron retort employed.

[2] See the article *Arsenious Acid*, in a subsequent part of this work, where full directions will be given for the application of these tests.

ric acid chars the parts of plants to which it is applied. In the dilute form it destroys vegetables in a few hours. (Marcet, in De Candolle's *Phys. Végét.* p. 1345.)

β. *On Animals generally.*—The action of sulphuric acid on animals generally is precisely the same as that on man. Thrown into the veins of a dog, Orfila found that it coagulated the blood, and caused immediate death. (*Toxicologie Générale.*)

γ. *On Man.*—Properly diluted, and administered in small but repeated doses, sulphuric acid acts like the other mineral acids (see pp. 189, 192, 198, and 207.) Thus it promotes the appetite, diminishes febrile heat, allays excessive thirst, checks profuse sweating, and, not unfrequently, reduces the frequency of the pulse. Sometimes it increases the secretion of urine, and likewise renders this fluid unusually acid. Under its use the milk frequently acquires a griping quality.

The continued use of it, however, generates a slow kind of gastro-enteritis: heat and pain are experienced in the throat, stomach, and intestines; the digestive functions become disordered; gripings are experienced; sometimes purging, and subsequently fever. Of all the mineral acids, save the phosphoric, this may be administered for the longest period without occasioning the above symptoms.

Concentrated sulphuric acid acts as an energetic caustic poison, promptly disorganizing the different tissues with which it is brought into contact. Its chemical action depends principally on its affinity for water, so that it chars or carbonizes the parts with which it is placed in contact. But its power of coagulating albuminous liquids, of combining with albumen to form a sulphate of this organic substance, and of dissolving fibrin, as well as coagulated albumen, contributes to its energetic escharotic action on the animal tissues. The parts to which the acid is applied become, in the first place, white by the formation of sulphate of albumen. This effect is seen both in the skin and the cornea. By the more prolonged action of the poison, they assume a brownish or blackish appearance, so that we can thereby frequently distinguish poisoning by this from poisoning by nitric acid; since this last-mentioned agent produces a yellow colour when applied to the skin. Black spots are frequently observed in the stomachs of those who have swallowed the acid; and in the surrounding parts the blood is usually coagulated in the blood-vessels. Such are the topical chemical effects of this acid. But besides these there are other phenomena of a local nature which may be denominated vital, since they depend on the reaction of the living parts. I refer now to those indicating the production of inflammation in the tissues in the immediate neighbourhood of those destroyed.

When strong sulphuric acid has been swallowed, the symptoms of poisoning are the following:—Alteration, or even destruction, of the soft parts about the mouth; burning pain in the throat, stomach, and bowels; frequently alteration of the voice, from the swelling and disorganization of the parts about the larynx; breath fetid, from the decomposed tissues; constant and abundant vomiting of matters, which may be bloody or otherwise, but which effervesce by falling on a marble hearth; bowels variously affected, sometimes constipated, though usually purged, the stools being bloody. The constitutional symptoms are principally those arising from a disordered action of the vascular system: thus the pulse is frequent and irregular, feeble, often imperceptible; extremities cold; great feebleness, or even fainting, with cold sweats. The same constitutional symptoms are observed when the stomach is wounded or ruptured. One remarkable characteristic is, that the mental faculties are unaffected, even up to a few minutes before death.

Not unfrequently the acid fails to produce speedy death from corrosion and inflammation, but gives rise to a peculiar organic disease of the stomach and intestines, of which the patient slowly dies, sometimes after several months' suffering.[1]

USES.—Sulphuric acid, properly diluted, may be administered in *febrile diseases*, as a refrigerant, to diminish thirst and preternatural heat; though in most of these cases, the vegetable acids are to be preferred. In the latter stage of fever (especially the kinds called typhoid) considerable benefit is sometimes gained by the use of a vegetable bitter (as calumba or cinchona) in combination with the diluted sulphuric acid. To assist the appetite and promote digestion, it is administered to patients recovering from fever. *To check profuse sweating* in pulmonary and other affections, whether phthisical or not, it is sometimes a valuable agent, as I have found on many occasions. No other remedy is so efficacious in relieving colliquative sweatings as this. In *hemorrhages*, as those from the nose, lungs, stomach, and uterus, it is commonly administered as an astringent, but its efficacy is doubtful. So also in purpura hæmorrhagica it is given with the same intention; but though I have several times employed it, I have not observed any evident benefit derived therefrom. In those forms of *lithiasis* attended with phosphatic sediments in the urine, the use of the mineral acids is at times beneficial. The sulphuric is preferred to the hydrochloric acid, since it can be continued for a longer period without occasioning gastric disorder. In *skin diseases*, especially lichen, prurigo, and chronic nettle-rash, it is sometimes serviceable. No remedy is so successful in relieving the distressing itching, formication, and tingling of the skin, as diluted sulphuric acid taken internally. In those forms of *dyspepsia* connected with an alkaline condition of the stomach, as in pyrosis, the sulphuric has been found to succeed better than hydrochloric acid. (Dr. D. Thomson, *British Annals of Med.* March 31, 1837.)

As a local agent, sulphuric acid is employed as a caustic, irritant, or astringent. As a caustic it has no advantage over many other agents, except that which arises from its liquid form, which, in most cases, renders it disadvantageous. For example, the difficulty of localizing it would be an objection to its employment in the production of an issue, but would be an advantage in applying it to wounds caused by rabbid animals or poisonous serpents, since the liquidity of the acid enables it to penetrate into all parts of the bites. In entropium, or that disease in which the eyelid is inverted, or turned inwards upon the eye, this acid has been applied as a caustic. In this complaint the friction of the eyelashes on the globe is most distressing, giving rise not only to inflammation, but even ulceration of the cornea. Now, when the disease is permanent, two modes of curing it have been proposed; either to remove a fold of the integument by the knife, so that, by the subsequent cicatrization, the lid may be drawn outwards—or to destroy a portion of the skin by a caustic, as sulphuric acid. The latter plan of treatment has been practised successfully by several eminent oculists, among whom I may name Mr. Guthrie and Mr. Lawrence. So also in ectropium, in which the lid is everted or turned outward, Mr. Guthrie has applied the concentrated acid to the inner side of the everted lid with advantage. An ointment containing sulphuric acid has been employed as a rubefacient in paralysis, and in the second stage of inflammation of the joints, when the violence of the disease has subsided; as a styptic to wounds, to suppress hemorrhage from numerous small vessels; and as a cure for scabies. Lastly, this acid, properly diluted, is employed as an astringent gargle in ulcerations of the mouth and throat: but after using it the mouth should be well rinsed, to prevent the action of the acid on the teeth.

ADMINISTRATION.—For internal use we generally make use of the *diluted sulphuric acid*, or the *elixir of vitriol.*

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[1] For farther information respecting the topical action of sulphuric acid, the reader may consult (besides Dr. Christison's *Treatise on Poisons*) the observations of Dr. R. D. Thomson, in the *Athenæum* for 1840, pp. 779 and 798; also the *Lancet* for 1836-7, vol. i. p. 195; and Mr. Taylor, in *Guy's Hospital Reports*, vol. iv.

ANTIDOTES.—In cases of poisoning by sulphuric acid, the antidotes are chalk, whiting, or magnesia, suspended in water. In the absence of these, soap-suds, infusion of wood-ashes, weak solutions of the alkaline carbonates, white of eggs, gelatine, milk, oil, or in fact any mild diluent, should be immediately administered. The subsequent treatment is that for gastro-enteritis. External parts burnt with oil of vitriol should be washed with a solution of soap or simple water.

1. **ACIDUM SULPHURICUM DILUTUM**, L. E. D. (U. S.) *Diluted Sulphuric Acid; Spirit of Vitriol*, or *Spiritus Vitrioli tenuis; Vitriol to clean Copper*. (Sulphuric Acid, f℥iss. [f℥j. *E.;* (U. S.) one part, *D.;*] Distilled Water, f℥xivss. [f℥xiij., *E.;* (U. S.) seven parts, *D.*] Add the acid to the water gradually, and mix. When the acid and water are mixed, condensation ensues, and heat is evolved.)—The white precipitate which forms is sulphate of lead. It is much to be regretted that the formulæ of the British colleges, for the preparation of this acid, should not have been uniform. The error which the Edinburgh College has fallen into, in consequence of this discrepancy, has been already (See. pp. 357 and 361, foot notes.) pointed out. Diluted sulphuric acid, prepared according to the directions of the London College, has a sp. gr. of about 1·11, and a fluid-drachm of it, which weighs 60·7 grs. saturates 28 grains of crystallized carbonate of soda: hence it contains 9½ grains of strong oil of vitriol, or 7·$\dot{7}$ grs. of anhydrous sulphuric acid, and its per-centage composition will be as follows:—

	By weight.		By weight.
Anhydrous Sulphuric Acid	12·8	Strongest Oil of Vitriol	15·7
Water	87·2	Water	84·3
Acidum Sulphuricum Dilutum, *Ph. L.*	100·0		100·0

The density of the Edinburgh diluted sulphuric acid is 1·090. The comparative strengths, by weight, of the Edinburgh and London preparations, are as 100 to 78: by volume the difference is still greater. (Mr. R. Phillips, *Lond. Med. Gaz.* Aug. 3, 1839, p. 689.) The dose of diluted sulphuric acid is from ♏x. to ♏xxx. or ♏xl., diluted with two or three table-spoonsful of some mild liquid. A most convenient preparation of it is the *Compound Infusion of Roses.* It may also be exhibited in Conserve of Roses.

2. **ACIDUM SULPHURICUM AROMATICUM**, E. D. (U. S.) *Aromatic Sulphuric Acid; Elixir of Vitriol*, or *Acid Elixir of Vitriol.*—("The *Edinburgh College* orders of Sulphuric Acid (commercial) f℥iiiss; Rectified Spirit, Oiss.; Cinnamon, in moderately fine powder, ʒiss.; Ginger, in moderately fine powder, ℥j. Add the acid gradually to the spirit; let the mixture digest at a very gentle heat for three days in a closed vessel; mix the powders, moisten them with a little of the acid spirit, let the mass rest for twelve hours, and then put it into a percolator, and transmit the rest of the acid spirit. This preparation may also be made by digesting the powders for six days in the acid spirit, and then straining the liquor.") [The only difference in the directions of the U. S. P. is the substitution of Oij. Alcohol for Oiss.] (The *Dublin College* orders of Rectified Spirit Oij. [*wine measure,*] Sulphuric Acid, *by weight*, ℥vj. Add the acid to the spirit gradually: digest the mixture in a closed vessel with an inferior heat, for three days; then add of Cinnamon bark, bruised, ʒiss.; Ginger root, bruised, ℥j. Digest the mixture again for six days; and, lastly, filter through paper placed in a glass funnel.) When oil of vitriol and rectified spirit are digested together, bisulphate of the oxide of ethule (formerly called sulphovinic acid) is formed (see p. 329.) The late Dr. Duncan, junior, (*Supplement to the Edinburgh Dispensatory*, p. 175. Edinb. 1829.) ascertained "that not a particle of gas is evolved by the mixture of alcohol and sulphuric acid in the proportions indicated." It is employed as an agreeable substitute for the diluted sulphuric acid; and is administered in the same doses. In a case of poisoning by ten drachms of this prepara-

tion, the symptoms were those of local irritation, with vomiting and purging of blood. The patient recovered. (*Lond. Med. Gaz.* vol. xxv. p. 944.)

3. UNGUENTUM ACIDI SULPHURICI, D. *Sulphuric Acid Ointment.*—(Sulphuric Acid, ʒj.; Prepared Hog's Lard, ℥j. Mix.) The ingredients should be mixed in a glass or earthenware mortar. The precise changes which sulphuric acid effects on lard have not been studied: they are most likely analogous to those effected by the acid on olive oil. The sulphuric acid probably unites on the one hand with the glycerine (oxide of glycerule) of the lard to form bisulphate of glycerine,—and on the other with the fatty acids (oleic, margaric (?) and stearic acids) of the lard. This ointment is of a buff colour. It is a powerful stimulant, and has been employed in paralysis, hemorrhages, and scabies, as before mentioned (see p. 408.)

3. A'CIDUM SULPHURO'SUM.—SULPHUROUS ACID.

History.—Homer (*Iliad*, xvi.) mentions sulphur fumigations. Stahl, Scheele, and Priestley, were the first to submit this acid to an accurate examination. It has been termed *Volatile Sulphurous Acid*, and, from the old mode of procuring it, *Spirit of Sulphur by the Bell* (*Spiritus Sulphuris per Campanan.*)

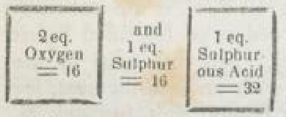
Natural History.—It escapes from the earth in a gaseous form, in the neighbourhood of volcanoes.

Preparation.—For chemical purposes it is prepared by mixing two parts of mercury with three parts of strong sulphuric acid, applying heat, and collecting over mercury. The results are, the bipersulphate of mercury and sulphurous acid.

For medicinal purposes, however, it is rarely, if ever, necessary to procure it in this way. By the combustion of sulphur in atmospheric air this gas is readily obtained; and when we are about to employ it, either as a disinfectant or vapour bath, this method is always followed.

Properties.—At ordinary temperatures and pressures it is a colourless and transparent gas, and has a remarkable and well-known odour. It is neither combustible nor a supporter of combustion. It reddens litmus and bleaches some colouring matters, especially infusion of roses, but the colour is restored by sulphuric acid. It is irrespirable, and has a sp. gr. of 2·2. It readily dissolves in water: recently boiled water takes up 33 times its volume of this gas. By cold and pressure it is readily condensed into a liquid.

Characteristics.—This acid is readily known by its peculiar odour (that of burning sulphur.) If the puce-coloured or binoxide of lead be added to it, the white protosulphate of lead is formed. An aqueous solution of this acid mixed with iodic acid, deoxidizes the latter, and sets iodine free, which may be recognised by its producing a blue colour with starch. A solution of an alkaline sulphate causes, with a soluble salt of barium, a white precipitate (*sulphate of baryta.*)



The sulphites evolve sulphurous acid by the action of strong sulphuric acid.

Composition.—If 16 parts by weight of sulphur be burned in one volume or 16 parts (by weight) of oxygen gas, we obtain one volume or 32 parts (by weight) of sulphurous acid gas.

The composition of this substance, may, therefore, be thus expressed:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Berzelius.*
Sulphur	1	16	50	49·968
Oxygen	2	16	50	50·032
Sulphurous Acid	1	32	100	100 000

Physiological Effects. α. *On Vegetables.*—It is a most powerful poison to plants, even in very minute quantities. (Christison, *On Poisons*, 3d ed. p. 750.)

β. *On Animals generally.*—The effects on animals have not been examined; but they are probably those of an irritant and asphyxiating agent.

γ. *On Man.*—Applied to the skin this acid gas causes heat, pain, and itching. If an attempt be made to inhale it in the pure state, it excites spasm of the glottis. Diluted with air it may be taken into the lungs, and there acts as a local irritant, causing cough, heat, and pain.

Uses.—It has been used as a disinfectant, as a remedy for the cure of itch, and as a nasal stimulant in syncope.

As a *disinfectant* it is mentioned by Homer. The mode of using it for this purpose is very simple. A pot containing burning sulphur is introduced into the room or place to be fumigated, and the doors and windows are carefully closed.

As a remedy for itch, baths of sulphurous acid gas are mentioned by Glauber in 1659. They are commonly termed *sulphur baths*, and may be had at most of the bathing establishments of the principal towns of this country. At the Hôpital St.-Louis, in Paris, a very complete apparatus for the application of this remedy in diseases of the skin has been erected by D'Arcet.[1] It is a kind of box, enclosing the whole body with the exception of the head. The sulphur is placed on a heated plate in the lower part of the box. From ten to twenty baths, or even more, are requisite for the cure of itch. "Sulphurous fumigations," says Rayer, (*Treatise on Diseases of the Skin*, by Dr. Willis, p. 347.) "which are employed in some hospitals are not attended with expense, leave no unpleasant smell, and do not soil the linen; but the long continuance of the treatment necessary to relieve the disease, more than counter-balances these generally insignificant recommendations." There are various other diseases of the skin in which baths of sulphurous acid have been found more or less successful, such as chronic eczema, lepra, psoriasis, impetigo, and pityriasis.[2]

As a stimulant in syncope or asphyxia this gas has been recommended by Nysten. It is readily applied by holding a burning sulphur match under the nose.

Antidotes.—When sulphurous acid gas has been inhaled, the patient should be made to respire the vapour of ammonia. A few drops of the solution of this substance should be swallowed.

4. SUL'PHURIS IO'DIDUM. (U. S.)—IODIDE OF SULPHUR.

History.—This compound was first described by Gay-Lussac. (*Ann de Chimie*, xci. 22. 1814.)

Preparation.—It is prepared by heating gently, in a clean oil flask, four parts of iodine with one part of sulphur until fusion is effected. Part of the iodine volatilizes, and the remainder unites with the sulphur.

Properties.—It is a black crystallizable compound, having the colour and radiated appearance of sesquisulphuret of antimony. It has the odour of iodine, and stains the cuticle, paper, &c. like this substance. Its elements are easily separated by heat.

Characteristics.—Boiled in water the iodine volatilizes with the steam, and the sulphur is deposited nearly in a state of purity.

Composition.—Its composition has not been determined. It is, probably, the following:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Iodine	1	126	79·75
Sulphur	2	32	20·25
Iodide of Sulphur	1	158	100·00

Physiological Effects. α. *On Animals.*—Dr. Cogswell (*Experimental Essay*

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[1] *Description des Appareils à Fumigations établis sur ses Dessins à l'Hopital Saint-Louis en* 1814, *et successivement dans plusieurs Hopitaux de Paris, pour le Traitement des Maladies de la Peau.* Paris, 1818.

[2] For farther information on this subject consult *Mémoire et Rapports sur les Fumigations Sulfureuses*, par J. C. Galés, 1816; *Observations on Sulphurous Fumigations*, by W. Wallace; *An Essay on Diseases of the Skin*, by Sir A. Clarke.

on Iodine and its Compounds.) gave three drachms to a bitch: the animal lost her appetite, was dull, and on the fourth day could not support herself properly upon her legs. On the twelfth day she was well.

β. *On Man.*—It has not been exhibited internally. It probably operates like iodine. Its local operation is that of a powerful stimulant and resolvent.

Uses.—Iodide of sulphur has been principally employed in the form of ointment, in various skin diseases. In *lupus* it has been found most efficacious by Biett, (Cazenove and Schedel, *Abrégé pratiq. sur les Malad. de la Peau.*) as well as Rayer. (*Treatise on Diseases of the Skin*, translated by Dr. Willis.) The last mentioned writer places it in the foremost rank of local remedies for this disease. In *acne indurata* and *rosacea* it has proved highly useful in the hands of Biett, (*Op. cit.*) Rayer, (*Op. cit.* p. 476.) and Dr. Copland. (*Dict. of Pract. Med.* art. *Acne*, p. 31.) In *lepra*, Rayer has observed good effects from its use; but in one case in which I tried it, it caused so much irritation that its use was obliged to be discontinued. In *herpes pustulosus labialis* it has been employed with great success by Dr. Volmar. (Dierbach, *Die neuesten Entdeck in d. Mat. Med.* 2te Ausg. 1er B. S. 449.) In *tinea capitis* it has also been recommended. (*Lond. Med. Gaz.* vol. xx. p. 879.)

Dr. Copland (*Op. cit.* art. *Asthma*, p. 149.) has employed the inhalation of the vapour of this substance in humoral asthma with temporary advantage.

UNGUENTUM SULPHURIS IODIDI; *Ointment of Iodide of Sulphur.*—This is composed of Iodide of sulphur and lard. The proportions vary according to circumstances: usually from 10 to 30 grains of the iodide to an ounce of lard. Magendie recommends 1 part of iodide to 18 or 19 of lard.

5. AMMO'NIÆ HYDROSUL'PHAS.—HYDROSULPHATE OF AMMONIA.

(Ammoniæ Hydrosulphuretum, *D.*)

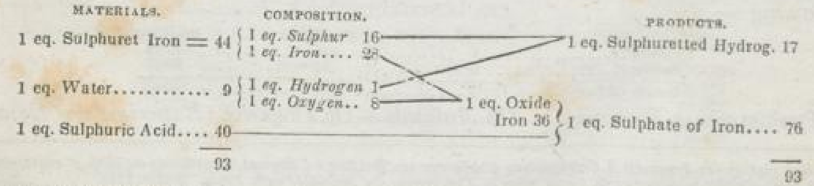
History and Synonymes.—This compound is said to have been first prepared in the seventeenth century by Boyle or Beguin: hence the terms *Boyle's fuming liquor* and *Beguin's sulphuretted spirit*, applied to one variety of it. The ordinary designation of it is *hydrosulphuret of ammonia*, or *hepatized ammonia.* Berzelius calls it *sulphuret of ammonia.*

Natural History.—It is evolved from decomposing animal matter (as in privies,) along with hydrosulphuric acid and nitrogen.

Preparation.—The following are the directions given by the Dublin College for the preparation of this compound:—

> Take of Sulphuret of Iron, reduced to a coarse powder, five parts; Sulphuric Acid, seven parts; Water, thirty-two parts; Water of Caustic Ammonia, four parts. Pass the sulphuret into a retort, then gradually pour on it the acid, first diluted with water, and, in a suitable apparatus, cause the elastic fluid to pass through the Water of Ammonia. Toward the end of the process, apply a moderate heat to the retort.

In this process the iron of the sulphuret is oxidized by the oxygen of the water, and the oxide of iron thus formed combines with the sulphuric acid to form sulphate of iron. The hydrogen of the water uniting with the sulphur of the sulphuret forms hydrosulphuric acid (*sulphuretted hydrogen.*)



The sulphuretted hydrogen thus produced is conveyed into a solution of ammonia, with which it combines.

PROPERTIES.—As thus prepared, the solution of hydrosulphuret of ammonia is a liquid, having a greenish yellow colour, a very fetid odour, and an acrid disagreeable taste. The mineral acids decompose it, evolve hydrosulphuric acid, and precipitate sulphur. It forms with a considerable number of metallic solutions, precipitates. With the salts of lead, bismuth, silver, and copper, the precipitates are blackish; with those of antimony, red; with those of cadmium and tin (persalts,) and with the arsenites (on the addition of an acid,) yellow; lastly, with the salts of zinc, white. In these cases the precipitates are either sulphurets or hydrated sulphurets of the respective metals.

By exposure to the air part of the ammonia flies off, and some sulphur is deposited. It is now a bi- or poly-sulphuret of ammonium, and yields a red precipitate with the salts of lead, a yellow one with tartar emetic, and a white one with arsenious acid.

Characteristics.—Its odour will readily distinguish it. As a sulphuret or hydrosulphuret it is known by its actions on the metallic solutions already noticed. Caustic potash causes the evolution of ammonia.

COMPOSITION.—Neutral hydrosulphate of ammonia has the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Hydrosulphuric Acid	1	17	50·00
Ammonia	1	17	50·00
Hydrosulphate of Ammonia	1	34	100·00

	Vol.
Hydrosulphuric Acid Gas	1
Ammoniacal Gas	2

Or it may regarded as a *Sulphuret of Ammonia* (S + NH^4.)

The fuming liquor (*Liquor Fumans Boyli*) obtained by distilling four parts of slaked lime, two of hydrochlorate of ammonia, and one of sulphur, contains, according to Gay-Lussac, (*Cours de Chimie*, Leçon 20e.) hydrosulphate of ammonia, with excess of sulphur; but in what state of combination has not been determined.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The vapour of this compound is injurious to vegetation.

β. *On Animals.*—I am unacquainted with any experiments made with it on animals; but analogy leads us to believe that its action is that of a powerful poison, analogous to other alkaline sulphurets, and to hydrosulphuric acid.

γ. *On Man.*—In *small* but *repeated doses* it acts powerfully on the secreting organs, the action of which it promotes, but at the same time modifies. Its principal influence is directed to the skin, (on which it acts as a sudorific,) and to the pulmonary mucous membrane. In *somewhat larger doses* it occasions nausea and giddiness. In *still larger doses* it causes nausea, vomiting, diminished frequency of pulse, giddiness, extreme languor, drowsiness, and sleep. *Excessive doses* would, of course, produce death, though I am unacquainted with any case of this kind.

In the gaseous state it acts, when inhaled, as a powerfully asphyxiating agent. Instances of its deleterious operation, in conjunction with hydrosulphuric acid, have occurred in France, in workmen exposed to the vapours from the pits (cesspools) of the necessaries. The symptoms are, sudden weakness, insensibility, and death; or where the vapours are less concentrated, there are sometimes delirium and convulsions.

USES.—In this country it has been principally employed in *diabetes mellitus*, with the view of reducing the morbid appetite and increased action of the stomach, as well as of the system in general. (Rollo, on *Diabetes Mellitus*, p. 28, ed. 2nd.) Combined with alcohol, F. Hoffmann administered it under the name of *liquor anti-podagricus*, as a powerful sudorific in gout. It has also been used in old pulmonary catarrhs; and by Brauw and Gruithuisen in vesical catarrh. (Vogt, *Pharmacodynamik*.)

ADMINISTRATION.—It is given in doses of from four to six drops, in some proper vehicle (distilled water is the best.) On account of its speedy decomposition, it should be dropped from the bottle at the time of using it.

ORDER XII.—COMPOUNDS OF SODIUM.

1. SO'DII CHLO'RIDUM, *L.* (U. S.)—CHLORIDE OF SODIUM.

(Sodæ Murias, *E. D.*)

HISTORY.—As this salt is a necessary and indispensable seasoning to our food, it doubtless must have been known to, and employed by, the first individuals of our race. The earliest notice of it occurs in the writings of Moses, (*Gen.* xix. 26; *Lev.* ii. 13.) and Homer. (*Iliad*, lib. ix. 214.) It has received various names, such as *Common Salt*, *Culinary Salt*, and *Muriate* or *Hydrochlorate of Soda.*

NATURAL HISTORY.—It occurs in both kingdoms of nature.

α. IN THE INORGANIZED KINGDOM.—An enormous quantity of this salt is contained in the waters of the ocean. At an average calculation sea water contains 2·5 per cent. of chloride of sodium. (Vide p. 246.) It is found also in great abundance in mineral waters. (Gairdner, *On Mineral Springs*, p. 12.) It has not hitherto been found in the oldest stratified rocks, (De la Bache, *Researches in Theoret. Geol.* p. 31.) but is met with in all the later formations. Thus Mr. Featherstonhaugh (*Phil. Mag.* N. S. vol. v. p. 139; vol. vi. p. 75; and vol. vii. p. 198.) states, that salt or brine springs occur in certain parts of the United States,[1] in the *old transition slate rocks.* Salt springs occur in various parts of England, in the *coal measures.* (Bakewell, *Introd. to Geology*, 4th ed. p. 252.) The rock salt of Cheshire, and the brine springs of Worcestershire, occur in the *old red sandstone group.* (*Trans. Geol. Society*, vol. i. p. 38, and vol. ii. p. 94.) The salt of Ischel, in the Austrian Alps, belongs to the *oolitic group*, (Sedgwick and Murchison, *Phil. Mag.* N. S. vol. viii. p. 102.) as does also that found in the lias in Switzerland. (Bakewell, *op. cit.* p. 253.) The immense mass or bed of salt near Cardona, in Spain, and which has been described by Dr. Traill, (*Trans. Geolog. Society*, vol. iii. p. 404.) occurs in the *cretaceous group.* (De la Bache, *op. cit.* p. 293.) The salt deposite of Wieliczka, near Cracow, belongs to the *supracretaceous group.* (Ibid, p. 270.) Lastly, in the Crimea, salt is said to be daily accumulating in the inland lakes.

β. IN THE ORGANIZED KIDGDOM.—It is found in plants which grow by the sea side, in the blood and urine of man, &c.

PREPARATION.—The salt consumed in this country is procured by the evaporation of the water of brine springs. The salt districts are, Northwich, Middlewich, and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and droitwich, in Worcestershire. In Cheshire the rock salt (called also *Fossil Salt*, *Sal Fossilis* or *Sal Gemmæ*) constitutes two beds, which vary in thickness from 4 to 130 feet, and are separated by a bed of clay, 10 or 12 feet thick; the uppermost bed of salt being 30 or more feet from the surface of the earth. It is for the most part of a reddish colour, but is also met with in transparent colourless masses. It is called in commerce, *Prussia rock*, and is largely exported for purification. Brine springs are met with both above and below the level of the beds of rock salt.

The brine is pumped up into cisterns or reservoirs, from which it is drawn when wanted into large oblong wrought-iron evaporating pans, which are usually worked with four or more fires. If the brine be not completely saturated with chloride of sodium, a little rock salt is added to it. By the evaporation of the water the salt deposites in crystals. The impurities separate in the form of a scum (which is removed by a skimming-dish,) and of a sediment called *pan-scale*, *pan-scratch*, or *pan-bake*. The grains or crystals of salt vary in size, according to the degree of heat employed in their preparation. The small-grained salt is formed by the strongest heat, and constitutes the *butter*, *stoved*, *lump*, or *basket salt* of commerce; while the larger crystals, forming the *bay* and *fishery salts* of commerce, are formed at a lower temperature.[2]

In some parts of the world chloride of sodium is obtained from sea water: but

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[1] For an account of the American salt formation, consult J. Van Rensselaer's *Essay on Salt, containing Notices of its origin, Formation, Geological Position, and principal Localities, embracing a particular Description of the American Salines.* New York, 1823.—This author states that the American salt formation occurs in the old red sand stone.

[2] For farther information on the manufacture of common salt, consult Aikin's *Dictionary of Chemistry*, vol ii. p 118; Holland's *Agricultural Survey of Cheshire*; Dr. Henry, *Phil. Trans.* 1810; Mr. Purnival's *Wharton and Marston Patent Salt Refineries*, 1836; Dr. Brownrigg's *Art of making Common Salt*, 1748; and Dr. Jackson, *Phil. Trans.* No. 53, p. 1060.