Antidotes.—In a case of poisoning by hydrochloric acid, the antidotes are chalk, whiting, magnesia or its carbonate, and soap; and in the absence of these, oil, the bicarbonated alkalis, milk, white of egg, or demulcents of any kind. Of course the gastro-enteritis is to be combated in the usual way.

ACIDUM HYDROCHLORICUM DILUTUM, L.; *Acidum Muriaticum dilutum*, E. (U. S.) (Hydrochloric Acid, f℥iv.; Distilled Water, f℥xij. "The density of this preparation is 1·050," *E.*) (U. S.) The dose is from ʒss. to ʒj. The most agreeable mode of exhibiting it is in the infusion of roses, substituting the hydrochloric for sulphuric acid.

4. AC'IDUM HYDRIOD'ICUM.—HYDRIODIC ACID.

Dr. Buchanan (*London Medical Gazette*, vol. xviii. p. 517.) has employed a solution of this acid in water. His formula for making it is as follows:—Dissolve 330 grs. of Iodide of Potassium in ℥iss. of Distilled Water, and to this add 264 grs. of Tartaric Acid also dissolved in ℥iss. of Distilled Water. When the Bitartrate of Potash has subsided, strain; and to the strained liquor add sufficient water to make fifty drachms (= ℥vj. ʒij.)—This solution, according to Dr. Buchanan, possesses all the therapeutical powers of iodine, without its irritant properties. He has given as much as ʒj. of it three times a-day, or ʒij. of iodine daily. He regards ℥ss. as the ordinary dose; but it would be much safer to begin with a smaller dose.

Order VI.—NITROGEN, AND ITS COMPOUNDS WITH OXYGEN AND HYDROGEN.

1. NITROGEN'IUM.—NITROGEN.

History and Synonymes.—This gas was first recognised in 1772, by Dr. Rutherford, who termed it *mephitic air*. Priestley called it *phlogisticated air*. Lavoisier named it *azote* from α privitive; and ζωη, *life*.) Cavendish, finding it to be a constituent of nitric acid, gave it the appellation it now usually bears, *nitrogen* (from νιτρον, *nitre;* and γενναω, *I beget*.)

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

α. In the Inorganized Kingdom.—It has not hitherto been found in non-fossiliferous rocks. It is a constituent of coal, of nitrates, of ammoniacal salts, and of some mineral waters. It forms 79 or 80 per cent. of the atmosphere.

β. In the Organized Kingdom.—It is a constituent of various vegetable principles, as the organic alkalis, gluten, and indigo blue; and is particularly abundant in the families *Cruciferæ* and *Fungi*. It enters into the composition of most animal substances, as albumen, fibrin, gelatine, mucus, urea, uric acid, &c. It is found in the swimming bladders of fishes.

Preparation.—The readiest method of procuring nitrogen is to burn a piece of phosphorus in a confined portion of atmospheric air. The phosphorus combines with the oxygen of the air and forms metaphosphoric acid. The residual gas, after being thoroughly washed, is nearly pure nitrogen.

Properties.—It is a colourless, odourless, tasteless gas; neither combustible nor a supporter of combustion. It neither reddens litmus, nor whitens lime water. Its sp. gr. is 0·9722 [0·976 Berzelius.] It is very slightly absorbed by water. Its equivalent by weight is 14 [14·19 Berzelius; 14·15 Turner,] by volume 1.

1 eq.
Nitrogen
= 14

Characteristics.—Nitrogen is usually distinguished by its negative properties just described. The only positive test for it is combining it with oxygen to form nitric acid. This may be effected in two ways; either by electrifying a mixture of nitrogen and oxygen, or by burning a stream of hydrogen in a mixture of oxygen and nitrogen. The nitric acid thus produced reddens litmus, and when absorbed by potash may be recognised by the tests hereafter to be mentioned. (See *Nitric Acid.*)

Physiological Effects.—The effects of nitrogen gas on vegetables and animals are analogous to those of hydrogen before mentioned. (See p. 238.) Thus, when inspired, it acts as an asphyxiating agent, by excluding oxygen; when injected into the blood it acts mechanically only. It is an essential constituent of the air employed in respiration.

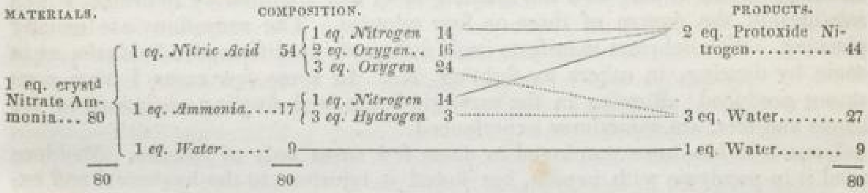
USES.—It has been mixed with atmospheric air, and inspired in certain pulmonary affections, with the view of diminishing the stimulant influence of the oxygen, and thereby of acting as a sedative.

2. NITROGEN'II PROTOX'YDUM.—PROTOXIDE OF NITROGEN.

HISTORY AND SYNONYMES.—This gas was discovered by Dr. Priestley in 1776. He termed it *dephlogisticated nitrous air.* Sir H. Davy[1] called it *nitrous oxide.* Its common name is *laughing gas.*

NATURAL HISTORY.—This compound is always an artificial production.

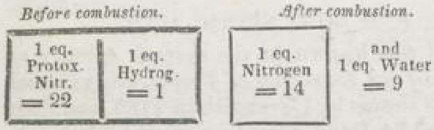
PREPARATION.—It is obtained by heating nitrate of ammonia in a glass retort. Every equivalent or 80 parts of the crystallized salt are resolved into four equivalents or 36 parts of water, and two equivalents or 44 parts of protoxide.



PROPERTIES.—At ordinary temperatures and pressure it is a colourless gas, with a faint not disagreeable odour, and a sweetish taste.—It is not combustible, but is a powerful supporter of combustion, almost rivalling in this respect oxygen gas. Protoxide of nitrogen does not affect vegetable colours. It undergoes no change of colour or of volume when mixed with either oxygen or the binoxide of nitrogen.

Its equivalent by weight, is 22 [22·2 Berzelius,] by volume 1. Its sp. gr. according to Dr. T. Thomson, is 1·5277. When subjected to a pressure of 50 atmospheres, at 45° F., it is condensed into a limpid colourless liquid.

Characteristics.—The only gas with which it is possible to confound it, is oxygen, with which it agrees in being colourless, not combustible, but a powerful supporter of combustion, re-inflaming a glowing match. From this it may be readily distinguished by mixing it with an equal volume of hydrogen, and exploding it by the electric spark, by which we obtain one volume or 14 parts of Nitrogen, and an equivalent or 9 parts of water. If a taper be burnt in a jar of this gas over water, a brown vapour (*nitrous acid gas*) is produced.



COMPOSITION.—It consists of one equivalent or 14 parts of nitrogen, and one equivalent or 8 parts of oxygen; or, by measure, a volume of nitrogen and half a volume of oxygen condensed into the space of one volume.

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Davy.*
Nitrogen	1	14	63·6	63·3
Oxygen	1	8	36·4	36·7
Protoxide Nitrogen	1	22	100·0	100·0

	Vol.	*Sp. gr.*
Nitrogen gas	1	0·9722
Oxygen gas	0·5	0·5555
Protox. Nitrogen gas	1	1·5277

PHYSIOLOGICAL EFFECTS. *α. On Vegetables.*—Germinating seeds (peas,) when watered with a solution of this gas, seemed unaffected by it. Plants introduced into vessels filled with the gas mostly faded in about three days, and died

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[1] *Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide, or Dephlogisticated Nitrous Air, and its Respiration.* 1800.

shortly after. (Davy's *Researches.*) But Drs. Turner and Christison did not find that it was injurious to vegetation. (Christison, *On Poisons*, p. 756.)

β. *On Animals.*—The effects of this gas on insects, annelides, mollusca, amphibials, birds, and mammals, were examined by Sir H. Davy. On all it acted as a positive poison. It produced "peculiar changes in their blood and in their organs, first connected with increased living action; but terminating in death." (Davy, p. 449.) Slowly injected into the veins of animals, considerable quantities were found by Nysten to produce slight staggering only; larger quantities produced the same disorder of the nervous system noticed when the gas is respired. (*Recherches*, pp. 77 and 78.)

γ. *On Man.*—When inhaled, its effects on the nervous system are most remarkable: I have administered this gas to about one hundred persons, and have observed that after the respiration of it from a bladder for a few seconds, it usually causes frequent and deep inspirations, blueness of the lips and countenance, an indisposition to part with the inhaling tube, and a temporary delirium, which subsides in the course of three or four minutes. The sensations are usually pleasing. The delirium manifests itself differently in different individuals; as in some by dancing, in others by fighting, &c. In some few cases I have seen stupor produced. Singing in the ears, giddiness, and tingling sensations in the hands and feet, are sometimes experienced.

Uses.—It has been employed in some few cases only of disease. Beddoes used it in paralysis with benefit, but found it injurious to the hysterical and exquisitely sensible. (Davy's *Researches*, p, 542.) In a remarkable case of spasmodic asthma, related by Mr. Curtis, (*Lancet*, vol. ii. for 1828 and 1829.) it acted beneficially. In a second case it also gave relief.

AQUA NITROGENII PROTOXYDI; *Protoxide of Nitrogen Water; Searle's Patent Oxygenous Aërated Water.*—At ordinary temperatures and pressures, water dissolves about three-fourths of its own bulk of protoxide of nitrogen; but by pressure the quantity may of course be augmented. The patent solution is said to contain five times its bulk of gas; or each bottle of the liquid is stated to hold a full quart of gas. Its effects on the system are not very marked. Sir H. Davy drank nearly three pints of the ordinary solution in one day, and says that it appeared to act as a diuretic; and he adds, "I imagined that it expedited digestion." (*Op. cit.* p. 237.) The proprietor of the patent water asserts that it exhilarates, and is adopted for torpor, depression of spirits, asthma, &c.

3. AC'IDUM NI'TRICUM, *L. E. D.* (U. S.) NITRIC ACID.

History and Synonymes.—This acid was known in the seventh century to Geber, who termed it *solutive water.* (*Of the Invention of Verity*, ch. xxi. and xxiii.) The nature of its constituents was shown by Cavendish in 1785, and their proportions were subsequently determined by Davy, Gay-Lussac, and Thomson. It has been known by various names, as *Glauber's spirit of nitre*, and *aquafortis.*

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

α. In the Inorganized Kingdom.—Combined with potash, soda, lime, or magnesia, it is found on the surface of the earth in various parts of the world. The nitrates have been found in some few mineral waters. Thus there is a district of Hungary, between the Carpathians and the Drave, where all the springs, for the space of about 300 miles, contain a small quantity of the nitrate of potash. (Gairdner, *On Mineral Springs*, p. 20.)

β. In the Organized Kingdom.—Nitrate of lime has been found in *Borago officinalis, Urtica dioica, Helianthus annuus*, and *Parietaria officinalis.* Nitrate of potash has been detected in the roots of *Cissampelos Pareira*, and *Geum urbanum*; in the juice of *Chelidonium majus*; in *Apium graveolens*; and sometimes in the root of *Beta vulgaris* when advanced in age. The same salt is also found in the flower of *Verbascum*, in the rhizome of *Zingiber officinale*, in the fruit of *Areca catechu*, in the tubercle of *Cyperus esculentus*, in *Agaricus acris*, and *A. edulis.*

PREPARATION.—Nitric acid is prepared by submitting a mixture of Oil of Vitriol and Nitrate of either Soda or Potash to distillation.

The apparatus used on the large scale is usually that employed in the manufacture of hydrochloric acid; namely, an iron or stoneware pot, with a stoneware head, which is connected with a row of double-necked stoneware bottles containing water. Another form of apparatus employed by some manufacturers, is an iron cylinder, set in brickwork over a fire-place. 168 lbs. of nitrate of potash are introduced at one end of the cylinder, which is afterwards closed by a circular disk of iron perforated to allow of the introduction of a leaden funnel, through which are poured 93 lbs. of strong sulphuric acid (sp. gr. 1·845.) The funnel is then removed, the aperture closed, and heat applied. The vapours are conveyed into a row of five or six bottles of stoneware filled to about one-sixth of their capacity with water. The acid obtained by this process is brown and fuming, and has a sp. gr. of 1·45. It is called in commerce *nitrous acid*, or *fuming nitric acid* (*acidum nitrosum; acidum nitroso-nitricum; acidum nitricum fumans*.) To render it colourless it is heated in a glass retort, placed in a sand bath: the vapour which escapes is passed through two stoneware bottles to save any acid that may be expelled, and is subsequently conveyed into a chimney. The colourless acid remaining in the retort has a sp. gr. of from 1·38 to about 1·4, and constitutes the *nitric acid of commerce* (*acidum nitricum venale*.) The residue in the iron cylinder is a mixture of sulphate with a little bisulphate of potash, and is sold as *sal enixum*. It is employed as a flux, and in the manufacture of alum.

The quantity of the ingredients employed in the above process is nearly in the proportion of eight equivalents or 392 parts of strong sulphuric acid, and seven equivalents or 714 parts of nitrate of potash.—Some manufacturers employ two parts by weight of nitrate of potash and one of strong sulphuric acid, or about an equivalent of each of the ingredients. As the water of the sulphuric acid is not sufficient in quantity to form liquid nitric acid with all the acid set free from the nitrate, a part of the nitric acid is decomposed into nitrous acid and oxygen. It is the presence of nitrous acid which communicates the red colour to the commercial or fuming nitric acid.

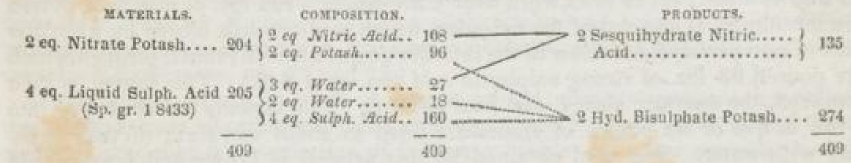
I am informed by a manufacturer who employs nitrate of soda in the production of nitric acid, that he obtains about as much by weight of nitric acid, sp. gr. 1·4, as of nitrate of soda consumed.

All the British Pharmacopœias give formulæ for the preparation of nitric acid. The *London* and *Edinburgh Colleges* use equal weights of dried Nitrate of Potash and Sulphuric Acid. The *Dublin College* directs 100 parts of Nitrate of Potash and 97 parts of commercial Sulphuric Acid. The distillation is to be conducted in a glass retort, by a sand heat. The directions of the Edinburgh College for obtaining pure nitric acid (*acidum nitricum purum*) are as follows:—

> "Purify Nitrate of Potash, if necessary, by two or more crystallizations, till Nitrate of Silver does not act on its solution in distilled water. Put into a glass retort equal weights of this purified nitrate and of sulphuric acid, and distil into a cool receiver, with a moderate heat from a sand-bath or naked gas-flame, so long as the fused material continues to give off vapour. The pale-yellow acid thus obtained may be rendered colourless, should this be thought necessary, by heating it gently in a retort."

Mr. Phillips states, that the acid obtained by the process of the London Pharmacopœia has a specific gravity of 1·5033 to 1·504. The Edinburgh College fixes the density of the pure acid at 1·500; and that of the commercial acid at 1·380 at least.

The explanation of the changes which take place is somewhat modified by the strength of the sulphuric acid employed. According to Mr. Phillips, the acid usually met with has a sp. gr. of 1·8433; I have found it generally somewhat below this. The acid alluded to by Mr. Phillips is composed, according to the same authority, very nearly of four equivalents or 160 parts of dry sulphuric acid, and five equivalents or 45 parts of water. These quantities react on two equivalents or 204 parts of nitrate of potash, and produce two equivalents or 135 parts of strong liquid nitric acid (sesquihydrate,) and one equivalent or 274 parts of the hydrated bisulphate of potash.



The generation of nitrous acid is greatest at the commencement and towards the close of the operation: for, at the commencement, the excess of uncombined sulphuric acid attracts water from the small quantity of nitric acid then set free, in consequence of which the latter is resolved into nitrous acid and oxygen: about the middle of the process, when the quantity of free nitric acid has increased, while that of sulphuric acid has diminished, the former passes over with water unchanged; but towards the end of the process, owing to the volatilization of the nitric acid, the sulphuric acid becomes again predominant, and the red vapours of nitrous acid then make their appearance.

PROPERTIES.—Strong and pure liquid nitric acid (*acidum nitricum purum*) is colourless, and has a peculiar odour, and an acrid, intensely sour taste. In the air it evolves white fumes, formed by the union of the acid vapour with the aqueous vapour of the atmosphere; these fumes redden litmus, and become much whiter when mixed with the vapour of ammonia, owing to the formation of the nitrate of ammonia. The sp. gr. of the acid, prepared according to the Pharmacopœia, is 1·5033 to 1·504, and Mr. Phillips believes this to be the strongest procurable; but Proust says he obtained it as high as 1·62; Kirwan, 1·554; Davy, 1·55; Gay-Lussac, 1·510: Thenard, 1·513. The Edinburgh College fixes the density of pure nitric acid at 1·500. The acid sold in the shops as *double aquafortis* (*aqua fortis duplex*) has a sp. gr. of 1·36. *Single aquafortis* (*aqua fortis simplex*) is of sp. gr. 1·22. Nitric acid has a powerful affinity for water; and, when mixed with it, heat is evolved.

Nitric acid is easily deprived of part of its oxygen. Thus, exposure to solar light causes the evolution of oxygen, and the production of nitrous acid, which gives the liquid a yellow, orange, or reddish-brown colour. The acid, thus coloured, may be rendered colourless by the application of a gentle heat, to drive off the nitrous acid. Several of the non-metallic combustibles rapidly decompose nitric acid; as charcoal, phosphorus, sugar, alcohol, volatile oils, resins, &c. The acid is unacted on by leaf-gold, platinum, &c. Some of the metals[1] also act powerfully on it, as copper (in the form of turnings,) and tin (in the state of foil.) A little water added to the acid facilitates, in some cases, the action of metals on it. The hydracids (as hydrochloric acid) decompose and are decomposed by nitric acid.

Characteristics.—Nitric acid is known by the following characters:—It stains the cuticle yellow or orange: mixed with copper filings, effervescence takes place, owing to the escape of binoxide of nitrogen, and a greenish-blue solution of nitrate of copper is obtained: the binoxide forms ruddy vapours in the air, by uniting with oxygen to form nitrous acid gas; and, passed into a solution of the protosulphate of iron, forms a dark olive-brown coloured liquid, which has a strong affinity for oxygen, and has in consequence been employed for analyzing atmospheric air: but the results obtained by it are uncertain. Nitric acid deco-

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[1] For an account of the anomalous relations of this acid and iron, I must refer the reader to Becquerel's *Traité de l'Electricité*, tom. v. p. 8.

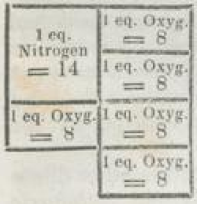
lourizes sulphate of indigo. Morphia, brucia, or commercial strychnia, communicates a red colour to nitric acid, which is heightened by supersaturating the liquor with ammonia: powdered nux vomica renders this acid yellow or orange-coloured. If hydrochloric acid be added to nitric acid, the mixture acquires the power of dissolving leaf-gold: the presence of gold in solution may be recognised by the protochloride of tin, with which it strikes a purple or blackish colour. Lastly, saturated with pure carbonate (or bicarbonate) of potash, a nitrate of potash is procured.

The *nitrates* are known by the following characters:—they evolve oxygen when heated, and deflagrate when thrown on a red-hot cinder or charcoal; when heated with sulphuric acid they disengage nitric acid, which may be recognised by its action on morphia, brucia, or commercial strychnia; lastly, when mixed with sulphuric acid and copper turnings, they generate binoxide of nitrogen, which is readily recognised by its blackening a solution of sulphate of the protoxide of iron. This last-mentioned property enables us to recognise very minute portions of the nitrates. The nitrate, copper filings, and sulphuric acid, are to be put into the test-tube: to which is adapted, by means of a cork, a small curved glass tube, containing at the bend a drop or two of the solution of the protosulphate of iron; heat is to be applied to the mixture in the test-tube, and in a few minutes the ferruginous solution becomes brown or blackish.

Composition.—*Anhydrous* or *dry nitric acid*, such as we find it in some nitrates, has the following composition by weight:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Lavoisier.*	*Cavendish.*	*Berzelius.*	*Davy.*
Nitrogen	1	14	25·9	20	25	26	29·5
Oxygen	5	40	74·1	80	75	74	70·5
Nitric Acid	6	54	100·0	100	100	100	100

According to Berzelius, its equivalent is 54·25 [54·15, Turner.]



Its composition by volume, is, one volume of nitrogen gas and two and a-half volumes of oxygen gas. The degree of condensation, however, is not known, as uncombined anhydrous nitric acid has not yet been procured.

Liquid nitric acid is composed of nitric acid and water. According to Mr. Phillips, when the specific gravity of the liquid is 1·5033 to 1·504, the composition is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Dry or Anhydrous Nitric Acid	1	54	80
Water	1½	13·5	20
Sesquihydrate of Nitric Acid	1	67·5	100

100 grains of this acid will saturate about 217 grains of carbonate of soda, equal to about 81 grains of real or dry nitric acid.

Impurities.—The presence of nitrous acid is known by the colour. To detect chlorine or the chlorides, dilute with distilled water, and apply nitrate of silver; a white chloride of silver is precipitated, which is insoluble in nitric acid, but soluble in ammonia. To recognise sulphuric acid, add a solution of chloride of barium to the diluted acid; a heavy white sulphate, insoluble in nitric acid, is thrown down. Any fixed impurities may be obtained by evaporation.

Physiological Effects. α. *On Vegetables.*—Nitric acid decomposes the different vegetable tissues to which it may be applied; and gives them a yellow colour.

β. *On Animals.*—Orfila found that 26 grains of commercial nitric acid, injected into the jugular vein, coagulated the blood, and caused death in two minutes. (*Toxicolog. Générale.*) Viborg threw a drachm of the acid, diluted with three drachms of water, into the jugular vein of two horses; in two hours they were well; the blood, when drawn, was slightly coagulated. (Wibmer, *Die Wirkung,*

&c.) Introduced into the stomach of dogs, it disorganizes this viscus, and causes death in a few hours.

γ. *On Man.*—On the *dead body*, M. Tartra has made various experiments to determine the appearances produced by the action of nitric acid. Of course this caustic decomposes the organic textures; but the phenomena presented vary according to different circumstances,—as the quantity employed, the presence of other substances, &c.

On the *living body*, its action varies with the degree of concentration or dilution of the acid. In the concentrated form the acid acts as a powerfully corrosive poison, which property it derives in part from its affinity for water, but more especially from the facility with which it gives out oxygen; so that the appearances caused by its action on some of the tissues are different from those produced by sulphuric acid. Thus the permanent yellow stain which it communicates to the cuticle is peculiar to it. Iodine, indeed, stains the skin yellow or brown, but a little caustic potash readily removes the stain when recent; whereas the yellowish stain produced by nitric acid, becomes orange on the addition of an alkaline soap. Bromine also stains the skin yellow, but when recently produced, the colour may also be removed by potash. The yellow or citron stain communicated to the lining membrane of the tongue, pharynx, &c. by nitric acid, has been well shown by Dr. Roupell. (See his *Illustrations of the Effects of Poisons.*) A preparation, presenting similar appearances, is preserved in the anatomical museum of the London Hospital. The yellow substance produced by the action of nitric acid on fibrin, was termed by MM. Fourcroy and Vauquelin the *yellow acid:* the same substance is probably produced by the application of nitric acid to other animal principles. This yellow substance is bitter, and is said by Berzelius to consist of yellow, altered fibrin, combined with nitric acid and with malic acid, formed by the action of some nitric acid on the fibrin. Nitric, like sulphuric acid, also chars the animal tissues, and thus, after the ingestion of it, the stomach is sometimes found blackened, as if sulphuric acid had been swallowed. The symptoms are analogous to those produced by sulphuric acid (see *Sulphuric Acid.*) The yellow, citron, or orange spots, sometimes observed on the lips, chin, or face, will, when present, at once indicate the kind of acid swallowed. Sometimes the binoxide of nitrogen is evolved by the mouth.

Properly diluted, nitric acid produces effects similar to those of the other dilute acids. (See pp. 182, 192, 198, and 207: also *Hydrochloric* and *Sulphuric Acids.*) It is said, however, to act less evidently as a tonic, and to be more apt to disagree with the stomach, so that it cannot be employed for so long a period. In some cases it has excited ptyalism, and from this circumstance, as well as from the occasional benefit derived from its use in the venereal disease, it has by some writers been compared, in its operation, to mercury; a comparison founded rather on theoretical than practical considerations.

Uses.—α. *Internal.*—As nitric acid produces certain effects, in common with other mineral acids, it may be used as a substitute for the latter in various diseases. Thus, it is administered in conjunction with the bitter infusions, in those conditions admitting of, or requiring, the use of tonics. Properly diluted, it is employed as a refrigerant in febrile disorders. In lithiasis, attended with phosphatic deposites in the wine, it may be used instead of the sulphuric or hydrochloric acid. In some obstinate cutaneous diseases, as impetigo, it is given to the extent of half a drachm daily in barley water. (Rayer, *Treatise on the Diseases of the Skin*, p. 502.) It may be employed also to relieve heartburn.

In 1793 this acid was used by Mr. Scott, a surgeon, at Bombay, as a substitute for mercurial preparations, which Girtanner erroneously fancied owed their efficacy to the quantity of oxygen which they contained. Mr. Scott first tried it in chronic hepatitis, and with considerable success. He then extended its use to venereal diseases, and obtained the happiest results from it.

Subsequently, it has been most extensively employed in the last-mentioned diseases; but the success attending its use has been very variable. That it has been, and is frequently serviceable, no one can doubt who reads the immense body of evidence offered in its favour by Scott, Kellie, Albers, Prioleau, Rollo, Cruickshank, Beddoes, (*Reports, principally concerning the Effects of the Nitrous Acid in Venereal Disease.* Bristol, 1797.) Ferriar, and others. But on the other hand it is equally certain that on very many occasions it has been useless. The same remark, indeed, may be made of mercury, or of any other remedy: but as an anti-venereal medicine it does not admit of comparison with this metal. However, we frequently meet with syphilitic cases in which the employment of mercury is either useless or hurtful. Thus it can rarely be employed with advantage in scrofulous subjects; or in persons whose idiosyncrasies render them peculiarly susceptible to the influence of this metal; and in sloughing sores it is inadmissible. Now these are the cases in which nitric acid may be employed with benefit; and I believe the best mode of administering it is in conjunction with the compound decoction of sarsaparilla.

For farther information respecting its employment, I must refer to the works of Holst (*De Acidi Nitrici usu Medico Dissertatio.* Christianæ, 1818.) and Mr. Samuel Cooper. (*Dict. of Practical Surgery.*)

β. *External.*[1]—In the *concentrated* state, nitric acid has been employed as a powerful caustic to destroy warts, and as an application to parts bitten by rabid animals or venomous serpents, to phagedenic ulcers, &c. In order to confine the acid to the spot intended to be acted on, the neighbouring parts may be previously smeared with some resinous ointment. In sloughing phagedæna the application of strong nitric acid, as recommended by Mr. Wellbank, (*Medico-Chirurg. Trans.* vol. xi.) is attended with the most successful results, as I have on several occasions witnessed. The best mode of applying it is by a piece of lint tied round a small stick or skewer. When the slough is very thick, it is sometimes necessary to remove part of it with a pair of scissors, in order to enable the acid to come in contact with the living surface.

Largely *diluted* (as 50 or 60 drops of strong acid to a pint or quart of water) it is recommended by Sir Astley Cooper as a wash for sloughing and other ill-conditioned sores.

In the form of *ointment* it is used in various skin diseases, especially porrigo and scabies, and as an application to syphilitic sores.

Nitric acid vapour has been employed to destroy contagion, but it is probably inferior to chlorine. It was first introduced for this purpose by Dr. Carmichael Smyth[2] (to whom Parliament granted a reward of £5000:) hence these fumigations have been termed *Fumigationes nitricæ Smythianæ.* The vapour is readily developed by pouring one part of oil of vitriol over one part of nitrate of potash in a saucer placed on heated sand.

Administration.—*Strong nitric acid* may be administered, in some mild diluent, in doses of from five to ten minims, three or four times daily.

Antidotes.—Poisoning by nitric acid requires precisely the same treatment as that by sulphuric acid. (See *Sulphuric Acid.*)

1. **ACIDUM NITRICUM DILUTUM,** L. E. D. (U. S.) *Diluted Nitric Acid;* (Nitric Acid, f℥j.; Distilled Water, f℥ix. *L.* (U. S.)—"Mix together three fluid ounces of Nitric Acid (commercial) and four fluid ounces of Water. If Pure Nitric Acid be used, four fluid ounces of it must be mixed with six fluid ounces of Water. The density of this preparation is 1·290." *E.*[22]—Nitric Acid, by mea-

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[1] On the external use of nitric acid, see *London Medical Repository*, vol. xiv. p. 450. 1820.

[2] *The Effects of the Nitrous Vapour in preventing and destroying Contagion:* Lond. 1799. Reviewed in the *London Medical Review*, vol. i. p. 433. Lond. 1799.

[22] Diluted nitric acid, Ph. Ed., prepared with pure nitric acid (sp. gr. 1·5.) has a sp. gr. 1·292, and contains 39·72 per cent. of real acid. But if prepared with commercial nitric acid (sp. gr. 1·381.) its sp. gr. is 1·11897, and it contains 26·40 per cent. of real acid. So that the strengths of these varieties of dilute nitric acid are to each other, by weight, as 100 to 66—by measure, as 100 to 60; a difference of 40 per cent. in acids prepared by the two modes directed.—(Mr. R. Phillips, *London Med. Gaz.* May 8, 1840, p. 273.)

sure, 3 parts; Distilled Water, by measure, 4 parts. *D.*) The sp. gr. of the diluted nitric acid of the London Pharmacopœia is 1 080; 100 grains of it saturate about 31 grains of crystallized carbonate of soda. The following is its composition:—

Dry or Anhydrous Nitric Acid - -	11·44	Strong liquid Nitric Acid (sesquihydrate) -	14·3
Water - - - - - - - -	88·56	Water - - - - - - - - -	85·7
Diluted Nitric Acid, Ph. L. - - -	100·00		100·0

The dose of this preparation is from thirty to forty minims.

2. UNGUENTUM ACIDI NITRICI, D. *Oxygenized Fat; Pommade d'Alyon.*—(Olive Oil, ℔j.; Prepared Hog's-lard, ℥iv.; Nitric Acid, by measure, ʒvss. Having melted the oil and lard in a glass vessel, when they are beginning to become concrete add the acid: then stir them constantly with a glass rod until they become firm.) The nitric acid undergoes partial decomposition, binoxide of nitrogen being evolved. Part of the fatty matter is oxydized and converted into *Elaïdine* (see *Unguentum Hydrargyri Nitratis.*) This ointment has a firm consistence and a yellow colour. Its uses have been above noticed. It is more efficacious when recently prepared.

4. AC'IDUM NI'TRO-HYDROCHLOR'ICUM.—NITRO-HYDROCHLORIC ACID.

(Acidum Nitro-muriaticum, *D.*) (U. S.)

History and Synonymes.—This liquid was known to Geber. (*Invention of Verity*, ch. xxiii.) It was formerly called *aqua regia.* Its nature was first explained by Davy.

Preparation.—It is readily prepared, according to the Dublin Pharmacopœia, by mixing 2 parts, by measure, of hydrochloric acid with 1 part, by measure, of nitric acid.

In the arts, however, hydrochlorate of ammonia, or common salt, is often substituted for hydrochloric acid; or nitrate of potash for the nitric acid.

By the reaction of one equivalent or 54 parts of nitric acid on one equivalent or 37 parts of hydrochloric acid, we obtain one equivalent or 46 parts of nitrous acid, one equivalent or 36 parts of chlorine, and an equivalent or 9 parts of water.

MATERIALS.	COMPOSITION.	RESULTS.
1 eq. Hydrochloric Acid... 37	1 *eq. Chlorine*.... 36	1 eq. Chlorine 36
	1 *eq. Hydrogen*... 1	1 eq. Water 9
1 eq. Nitric Acid 54	1 *eq. Oxygen* 8	
	1 *eq. Nitrous Acid* 46	1 eq. Nitrous Acid.... 46
91	91	91

Properties.—It has a yellow colour. Its most remarkable property is that of dissolving gold and platinum, metals that are insoluble in either nitric or hydrochloric acid separately. It should be kept in a cool dark place, for heat rapidly expels the chlorine, while light enables it to decompose the water and to form hydrochloric acid.

Characteristics.—It is recognised by its colour, by its power of dissolving gold, by its precipitating a solution of the nitrate of silver, the precipitate being insoluble in nitric acid, but soluble in ammonia; by the production of two salts, a chloride and a nitrate, when an alkali is added to it; and by the evolution of binoxide of nitrogen on the addition of copper turnings (see *Nitric Acid.*)

Physiological Effects.—It is a powerfully corrosive poison, acting in a similar manner to nitric acid.

Uses.—It has been employed *internally* in the same cases as nitric acid, more especially syphilis, diseases of the liver, and some of the exanthemata. *Externally* it has been used as a bath, either local or general, in syphilis and hepatic affections. Dr. Lendrick (*British and Foreign Medical Review*, vol. iv. p. 254.) has more recently noticed the utility of the general nitro-muriatic bath, at a temperature of 90° or 95°, in syphiloid and mercurial cachexiæ, and liver consumption. In India the whole body (the head excepted) is immersed; but in this country pediluvia only are usually employed, or the body is merely sponged with it.

Administration.—When taken internally the dose is ten or fifteen drops properly diluted, and carefully increased.

Antidote.—Poisoning by this acid is to be treated in the same way as that by sulphuric acid.

BALNEUM NITRO-HYDROCHLORICUM.—The nitro-muriatic bath[1] is prepared in wooden tubs, by adding this acid to water, until the latter becomes as acid to the taste as vinegar (from 4½ to 6 fluid-ounces of the acid to about 3 gallons of water in a deep narrow tub.) The patient should remain in the bath from 10 to 30 or 40 minutes. It excites tingling and prickling of the skin, and is said to affect the gums and salivary glands, causing plentiful ptyalism; indeed, we are told that, without the latter effect, every trial is to be regarded as inconclusive. In the passage of biliary calculi this bath is said to have proved remarkably effective.

5. AMMO'NIA.—AMMONIA OR AMMONIACAL GAS.

History and Synonymes.—It is probable that Pliny was acquainted with the smell of Ammonia, and that the "vehement odour" which he says (*Historia Naturalis*, lib. xxxi. cap. 46. Ed. Valp.) arose from mixing lime with nitrum was produced by the action of lime on sal ammoniac. Dr. Black, in 1756, first pointed out the distinction between ammonia and its carbonate; and Dr. Priestley (*On Air*, vol. ii. p. 369, 1799.) first procured ammonia in a gaseous form. He called it *alkaline air*. It is sometimes termed *volatile alkali*, and occasionally *azoturetted hydrogen*.

Natural History.—Ammonia, free or combined, exists in both kingdoms of nature.

α. In the Inorganized Kingdom.—Hydrochlorate and sulphate of ammonia are met with native usually in the neighbourhood of volcanoes. Aluminous sulphate of ammonia (or ammonia-alum) occurs in Bohemia. Dr. Marcet detected the hydrochlorate in sea water. This salt has also been recognised in mineral waters. (Gairdner, *On Mineral Springs*, p. 15.) Ammonia exists in many of the native oxides of iron, and in some chalybeate waters. Carbonate of ammonia exists in rain water. (See p. 243.)

β. In the Organized Kingdom.—Ammonia is found in vegetables, in small quantities only. In the free state, it is said to exist in several plants, as *Chenopodium vulvaria*, *Sorbus aucuparia*, (*Dict. des Drogues*, t. i. p. 293.) in the juice of the leaves of *Isatis tinctoria*, in the bark of *Zanthoxylum Clava Herculis*, and in *Fucus vesiculosus*. Combined with carbonic acid, it is found in *Justicia purpurea;* with nitric acid, in the extract of hyoscyamus, distilled water of the lettuce, &c. In combination with different substances, it is found in the root of *Helleborus niger*, and of *Nymphæa;* in the leaves of *Aconitum Napellus;* in the barks of *Cusparia febrifuga* and *Simaruba;* and in the fruit of *Areca Catechu*. (De Candolle, *Physiol. Végét.* p. 339.) Lastly, it is developed during the decomposition (spontaneous or artificial) of most vegetable substances which contain nitrogen; as gluten.

Ammonia is one of the bases found in the urine of man, where it exists in combination with phosphoric, hydrochloric, and uric acids. United to the last-mentioned acid, it exists in the excrement of the Boa constrictor, and of some birds. The hydrochlorate is found in the dung of the camel. Ammonia is one of the products of the putrefaction of animal matters.

Preparation.—Ammoniacal gas is obtained by heating a mixture of hydrochlorate of ammonia and quicklime in a glass retort, and collecting over mercury. In the absence of a mercurial apparatus, the gas may be generated in a Florence flask, to the mouth of which a straight glass tube is connected by means of a

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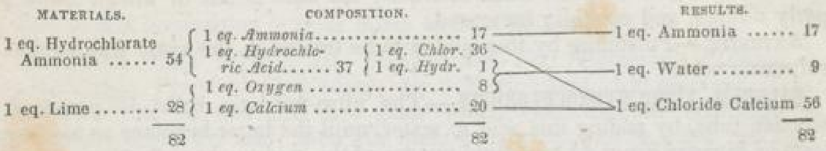
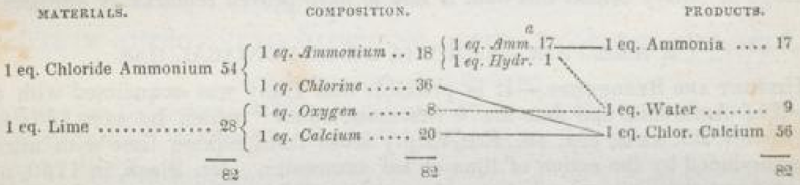
[1] See Coyne's *Observations on the Aid obtained in various Diseases, particularly those incidental to Tropical Climates, by the external application of the Nitro-muriatic Acid in a Bath* Lond. 1822.

cork. The bottles which are to be filled with gas are to be inverted over the tube.

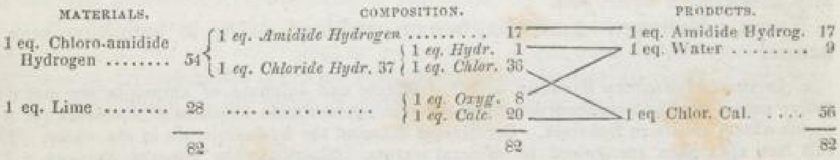
In this process, one equivalent or 54 parts of hydrochlorate of ammonia are decomposed by one equivalent or 28 parts of lime; and the results of the decomposition are one equivalent or 17 parts of ammonia; one equivalent or 56 parts of chloride of calcium, and one equivalent or 9 parts of water.

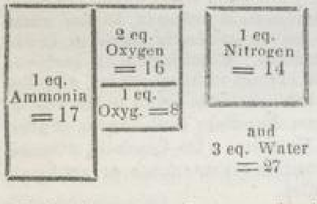


If we adopt the ammonium theory, the production of ammonia in the above process may be thus explained: one equivalent or 54 parts of chloride of ammonium is decomposed by one equivalent or 28 parts of lime, and the products of the reaction are as above stated.



But, according to Dr. Kane, ammonia is an *amidide of hydrogen*, and sal ammoniac is a *chloro-amidide of hydrogen*; and the changes are thus explained:—





Properties.—It is a colourless invisible gas, having a strong and well-known odour. It reddens turmeric paper, and changes the colour of violet juice to green; but by exposure to the air, or by the application of heat, both the turmeric paper and violet juice are restored to their original colour. The specific gravity of this gas is 0·59. By a pressure of 6·5 atmospheres, at a temperature of 50°, it is condensed into a colourless, transparent liquid. Ammoniacal gas is not a supporter of combustion, but is slightly combustible in the atmosphere, and when mixed with air or oxygen, it forms an explosive mixture. Every two volumes of ammoniacal gas require one and a half volumes of oxygen for their complete combustion. The results of the explosion are, a volume of nitrogen and some water.

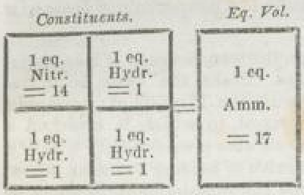
Characteristics.—It is readily recognised by its peculiar odour, its action on turmeric paper, and by its forming white fumes with hydrochloric acid or chlorine. Dissolved in water it communicates a deep blue colour to the salts of copper, throws down a yellow precipitate (*platina-bichloride of ammonia*) with the bichloride of platinum, and a white one with bichloride of mercury.

Conia agrees with ammonia in evolving a vapour which reddens turmeric paper, and forms white fumes (hydrochlorate of conia) with hydrochloric acid gas.

Composition.—Ammonia is composed of hydrogen and nitrogen, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*A. Berthollet.*		*Vol.*	*Sp. Gr.*
Nitrogen	1	14	82·35	81·13	Nitrogen gas	1	0·97222
Hydrogen	3	3	17·65	18·87	Hydrogen gas	3	0·20833
Ammonia	1	17	100·00	100·00	Ammoniacal gas	2	0·59027

According to Berzelius, its equivalent is 17·19 [17·15, Turner.]



The annexed diagram illustrates the volumes of the constituents of the gas, and their degree of condensation when in combination to form ammoniacal gas.

Hypothetically, Dr. Kane (*Transactions of the Royal Irish Academy*, vol. xix. part. 1.) has regarded ammonia as a compound of a suppositious substance called *amidogen*, (N 2 H,) and hydrogen: in other words, as an amidide of hydrogen.

Physiological Effects. *α. On Vegetables.*—Ammoniacal gas is destructive to plants, and changes their green colour to brown. (De Candolle, *Physiol. Vég.* p. 1344.)

β. On Animals.—If an animal be immersed in this gas, spasm of the glottis is immediately brought on, and death results from asphyxia. Nysten (*Recherches*, p. 140.) injected some of this gas into the veins of a dog: the animal cried out, respiration became difficult, and death soon took place. Neither gas nor visible lesion was observed in the heart, the two ventricles of which contained liquid blood. In another experiment he threw ammoniacal gas into the pleura of a dog: cries, evacuation of urine, and vomiting, immediately followed; soon afterwards convulsions came on, and continued for several hours: ultimately they ceased, and recovery took place.

In almost all cases of poisoning in animals, by ammonia, or its carbonate, convulsions are observed, apparently showing that these substances act on the spinal marrow.

γ. On Man.—Ammonia is a powerful local irritant. This is proved by its pungent odour, and its acrid and hot taste; by its irritating the eyes; and, when applied for a sufficient length of time to the skin, by causing vesication. If an attempt be made to inhale it in the pure form, spasm of the glottis comes on: when diluted with atmospheric air, it irritates the bronchial tubes and larynx, and, unless the quantity be very small, brings on inflammation of the lining membrane. Its powerful action on the nervous system is best seen in cases of syncope, (See *Aqua Ammoniæ.*)

Uses.—Ammoniacal gas is rarely employed in medicine. M. Bourguet de Bêziers used it with success in the case of a child affected with group, to provoke the expulsion of the false membrane.

Antidote.—In case of the accidental inhalation of strong ammoniacal vapour, the patient should immediately inspire the vapour of acetic or hydrochloric acid. If bronchial inflammation supervene, of course it is to be treated in the usual way.

6. A'QUA AMMO'NIÆ.—WATER OF AMMONIA.

(Liquor Ammoniæ, and Liquor Ammoniæ Fortior, *L.*—Aqua Ammoniæ, and Aqua Ammoniæ Fortior, *E.*—Aqua Ammoniæ causticæ, *D.*)—(Liquor Ammoniæ, U. S.)

History.—This solution was formerly termed *spiritus salis ammoniaci causticus cum calce viva paratus.*

Preparation.—It is prepared by the action of lime on either sulphate or hydrochlorate of ammonia. On the large scale, the apparatus employed is an iron cylinder, connected with the ordinary worm refrigerator, and this with a row of double-necked stoneware bottles containing water, analogous to those described under the head of nitric acid.

All the British Colleges give formulæ for its preparation. The following are the directions of the *London College*:—

"Take of Hydrochlorate of Ammonia ten ounces, Lime eight ounces, Water two pints: put the Lime, slaked with water, into a retort, then add the Hydrochlorate of Ammonia, broken into small pieces, and the rest of the water. Let fifteen fluid ounces of solution of ammonia distil."

The *Edinburgh College* gives the following directions for preparing *Ammoniæ Aqua*, and *Ammoniæ Aqua Fortior.*

"Take of Muriate of Ammonia, thirteen ounces; Quicklime, thirteen ounces; Water, seven fluid ounces and a-half; Distilled Water, twelve fluid ounces. Slake the Lime with the Water, cover it up till it cool, triturate it well and quickly with the Muriate of Ammonia previously in fine powder, and put the mixture into a glass-retort, to which is attached a receiver with a safety tube. Connect with the receiver a bottle also provided with a safety tube, and containing four ounces of the distilled water, but capable of holding twice as much. Connect this bottle with another loosely corked, and containing the remaining eight onces of distilled water. The communicating tubes must descend to the bottom of the bottles at the farther end from the retort; and the receiver and bottles must be kept cool by snow, ice, or a running stream of cold water. Apply to the retort a gradually-increasing heat till gas ceases to be evolved; remove the retort, cork up the aperture in the receiver where it was connected with the retort, and apply to the receiver a gentle and gradually increasing heat, to drive over as much of the gas in the liquid contained in it, but as little of the water, as possible. Should the liquid in the last bottle not have the density of ·960, reduce it with some of the stronger Aqua Ammoniæ in the first bottle, or raise it with distilled water, so as to form Aqua Ammoniæ of the prescribed density."

The *Dublin College* employs 3 parts of Muriate of Ammonia, two of fresh burned Quicklime, and ten of Water. The lime is to be slaked with one part of hot water, and then introduced into the retort, and the salt dissolved in the remaining hot water, added, and five parts distilled by a medium [between 100° and 200°] heat into a refrigerated receiver.

[*The U. S. Pharmacopœia* directs to take of Muriate of Ammonia in fine powder, Lime, each a pound; Distilled water a pint; Water, nine fluid ounces. Break the lime in pieces and pour the water upon it in an earthen or iron vessel; then cover the vessel and set it aside till the lime falls into powder and becomes cold, mix this thoroughly with the Muriate of Ammonia in a mortar, and immediately introduce the mixture into a glass-retort. Place the retort upon a sand bath and adapt to it a receiver, previously connected, by means of a glass tube, with a quart bottle containing the distilled water. Then apply heat, to be gradually increased till the bottom of the iron vessel becomes red hot; and continue the process so long as the Ammonia comes over. Remove the liquor contained in the quart bottle, and for every fluid ounce of it add three and a-half fluid drachms of distilled water, or so much as may be necessary to raise its specific gravity to 0·96. Keep the solution in small bottles well stopped.]

The theory of the process is the same as that for ammoniacal gas. An excess of lime is used to facilitate the extrication of the ammonia. The water put into the receiver is to absorb the gas.

PROPERTIES.—Solution of ammonia is a colourless liquid, having a very pungent odour, and a caustic alkaline taste. Its action on turmeric paper, and violet juice is like that of ammoniacal gas before described. It is lighter than water, but its sp. gr. varies with its strength. In the shops, a very strong solution (called *Liquor Ammoniæ Fortior*) is kept, having a sp. gr. of about 0·880: it is employed for smelling-bottles. One fluid ounce of Aqua Ammoniæ Fortior (sp. gr. 0·880) with three of water makes Aqua Ammoniæ of about sp. gr. 0·970.[1] Prepared according to the London and Edinburgh Pharmacopœias, the sp. gr. is 0·960; according to the Dublin, 0·950. A cubic inch of Liquor Ammoniæ (sp. gr. 0·960) weighs 242·36 grs., and it contains 132 cubic inches of ammoniacal

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[1] In the Edinburgh Pharmacopœia it is stated that the density of the above mixture is 0·960, but this is an error. Two fluid ounces of water with one fluid ounce of aqua ammoniæ fortior yield a mixture whose sp. gr. is 0·960.

gas in condensed solution. A cubic inch of Liquor Ammoniæ Fortior (sp. gr. 0·882) weighs 222·66 grs., and it holds dissolved nearly 400 cubic inches of ammoniacal gas. (Mr. R. Phillip's *Translation of the Pharmacopœia*, 4th edit.) The quantity of Ammoniacal gas, which water can dissolve, varies with the pressure of the atmosphere and the temperature of the water.

Davy (*Elements of Chemical Philosophy*, p. 268.) ascertained that at the temperature of 50°, under a pressure equal to 29·8 inches, water absorbs about 670 times its volume of gas, and becomes of sp. gr. 0·875. He drew up the following table showing the quantity of ammonia in solutions of different specific gravities:—

100 parts of Sp. Gr.	Of Ammonia.	100 parts of Sp. Gr.	Of Ammonia.
0·8750	contain 32·50	0·9435	contain 14·53
0·8875	29·25	0·9476	13·46
0·9000	26·00	0·9513	12·40
0·9054	25·37	0·9545	11·56
0·9166	22·07	0·9573	10·82
0·9255	19·54	0·9597	10·17
0·9326	17·52	0·9619	9·60
0·9385	15·88	0·9692	9·50

It appears from the observations of Davy and Dalton that the specific gravity of mixtures of liquid ammonia and water is exactly the mean of that of the two ingredients.

COMPOSITION.—From the above observations, the composition of officinal solutions of ammonia is nearly as follows:—

	Lond. and Edinb. Ph. (sp. gr. 0·960)	*Dub. Ph.* (sp. gr. 0·950)	*Liq. Am. Fort.* (sp. gr. 0·880)
Ammoniacal gas	10	12·5	30·5
Water	90	87·5	69·5
Liquor Ammoniæ	100	100·0	100·0

CHARACTERS—(See *Ammoniacal Gas.*)

IMPURITIES.—Liquor ammoniæ frequently contains traces of carbonate of ammonia, which may be detected by lime-water, or by a solution of the chloride of calcium, either of which occasions a white precipitate (*carbonate of lime*) if carbonic acid be present. When a portion of the liquid has been neutralized by pure nitric acid, it ought not to cause a precipitate by the addition of nitrate of silver, of oxalic acid, or of sesquicarbonate of ammonia: for the first would indicate the presence of hydrochloric acid, or chlorine; the second, of lime; the third, of lime, or other earthy matter. If pure, it does not effervesce with dilute acids.

INCOMPATIBLES.—It is hardly necessary to state that all acids are incompatible with ammonia. With the exception of the salts of potash, soda, lithia, baryta, and strontia, ammonia decomposes most of the metallic salts.

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—The effects of ammonia on plants have been before noticed.

β. *On Animals.*—Orfila injected sixty grains of liquor ammoniæ into the jugular vein of a strong dog: tetanic stiffness immediately came on, the urine passed involuntarily, and the animal became agitated by convulsions: death took place in ten minutes. The body was immediately opened, when the contractile power of the muscles was found extinct. In another experiment, thirty-six grains of concentrated solution of ammonia were introduced into the stomach, and the œsophagus tied: in five minutes the animal appeared insensible, but in a few moments after was able to walk when placed on his feet; the inspirations were deep, and his posterior extremities trembled. In twenty hours he was insensible, and in twenty-three hours he died. On dissection, the mucous membrane of the stomach was found red in some places. These experiments show the effects of large doses of this solution on the nervous system. The first experiment agrees in its results (that is, in causing tetanic convulsions) with that made by Nysten, and which has been before mentioned, of throwing ammoniacal gas into the cavity of the pleura. From the convulsions it may be inferred, that in these instances the (gray matter of the) spinal marrow was specifically affected.

γ. *On Man.* αα. *Local Effects.*—In the concentrated form the local action of liquor ammoniæ is exceedingly energetic. Applied to the skin, it causes pain, redness, vesication, and destruction of the part; thus acting, first as a rubefacient, then as a vesicant, and lastly as a caustic or corrosive. Its emanations are also irritant: when they come in contact with the conjunctival membrane, a flow of tears is the result; when inhaled, their powerful action on the air-passages is well known. Persons in syncope are observed to be almost immediately raised from a death-like state, merely by inhaling the vapour of this solution. In cases of insensibility it must be employed with great caution; for, if used injudiciously, serious, or even fatal, consequences may result. Nysten (Christison, *Treatise on Poisons.*) tells us that a physician, for some years subject to epilepsy, was found by his servant in a fit. In order to rouse his master, the latter applied a handkerchief, moistened with this solution, to his nose, so assiduously, that he brought on bronchitis, of which the patient died on the third day. In the *Edinburgh Medical and Surgical Journal*, there is the report of the case of a lad whose death was produced, or at least hastened, by an attendant applying, "with such unwearied but destructive benevolence," ammonia to the nose, that suffocation had almost resulted. Dyspnœa, with severe pain in the throat, immediately succeeded, and death took place 48 hours afterwards. A French physician also suffered ulceration of the mouth, and violent pulmonary catarrh, in consequence of the excessive use of ammonia, given as an antidote for hydrocyanic acid. More recently, another case of poisoning by the vapour of ammonia has been published. (*Journal de Chimie Médicale*, t. vi. p. 499, 2^{nde} Sér.) It arose from the accidental bursting of carboy of liquor ammoniæ. The mucous membrane of the nose and lips was destroyed. The tongue was deprived of its epithelium, and a large quantity of sanguineous froth escaped from the mouth. The respiration was so difficult, that suffocation was feared. The pulse was feeble, irregular, and frequent. There were no convulsions. Bronchitis supervened, but the patient recovered.

When the solution of ammonia is swallowed in large doses, it acts as a powerfully corrosive poison; but modern well-marked cases of poisoning by it in the human subject are wanting. However, it is very evident that violent inflammation of all that part of the alimentary canal with which the poison may be in contact, would be the result, and that if much were taken, decomposition of the part might be expected. When swallowed in a very dilute form, and in small quantity, the local phenomena are not very marked, and the effect of the substance is then seen in the affection of the general system.

The chemical action of ammonia on the tissues is analogous to that of potash, hereafter to be described.

ββ. *Remote Effects.*—The remote effects may be investigated under two heads, according as they are produced by small or large doses. *In small or therapeutic doses*, such as we are accustomed to employ in the treatment of diseases, ammonia acts as a stimulant, excitant, or calefacient. It produces a sensation of warmth in the mouth, throat, and epigastrium, frequently attended with eructations. A temporary excitement of the vascular system succeeds, but this quickly subsides. The heat of the skin is sometimes increased, and there is a tendency to sweating, which, if promoted by the use of warm diluents and clothing, frequently terminates in copious perspiration. But the skin is not the only secreting organ stimulated to increased exertion; we observe the kidneys produce more urine, and frequently the quantity of bronchial mucus is increased. The nervous system is also affected, and the activity of its functions heightened. Wibmer (*Die Wirkung*, &c. Bd. i. S. 123.) made several experiments on himself, and from them it appears that ammonia affects the head, sometimes causing oppression, or a sense of fulness, but no pain. The increased capability of muscular exertion, and the greater facility with which all the functions are executed, are farther indications of the action of ammonia on the nervous system.

There is, however, something remarkably different between the stimulant effects of ammonia and those of alcohol or opium. The first may be employed with great benefit in many inflammatory and febrile cases, in which the latter proves highly prejudicial. Ammonia, observes Dr. Billing, (*First Principles of Medicine*, p. 158, 4th ed. Lond. 1841.) is *not*, like wine and tincture of opium, a diffusible stimulant. "In the first place, ammonia is used empirically by the most able of the profession, in cases where they know from experience that they must not employ wine or tincture of opium. This alone shows that it is not really a diffusible stimulant—it is a local one; and as such, through the medium of the solar plexus, excites the heart momentarily, though not injuriously. Again, so far from being a diffusible stimulus, it immediately unites with animal acids, and then circulates, or is *diffused*, not as a stimulant, but as a *sedative* saline; so as to perform the double operation of a temporary local stimulant to the stomach and heart, and a sedative to inflamed capillaries elsewhere, although the latter indication be not contemplated in its administration."

The effects of large or poisonous doses on the human subject have not been described: but that the nervous system is affected, seems probable from a case mentioned by Plenck, (*Toxicologia*, p. 226, Ed. 3$^{\text{nda}}$. Viennæ, 1801.) which terminated fatally in four minutes; though the symptoms are not related. (See *Ammoniæ Sesquicarbonas.*)

If we compare the effects of ammonia with those of other stimulants, as camphor, wine, and opium, we observe, in the first place, that the influence of ammonia is principally manifested in the ganglionic and true spinal systems,—while the other stimulants, above mentioned, affect the cerebral system. Thus the effects of ammonia are usually exhibited on the circulation, respiration, secretion, and spasmodic actions: but camphor, wine, and opium, though they also affect these functions, yet they principally affect the intellectual functions. Secondly, the effects of ammonia are more transient than those of the other agents just referred to. Thirdly, the vascular excitement caused by wine and opium is attended with diminished mucous secretion, and is allied more to an ordinary febrile attack.

USES.—Ammonia is adapted for speedily rousing the actions of the vascular and respiratory systems, and for the prompt alleviation of spasm. It is more especially fitted for fulfilling these indications when our object is at the same time to promote the action of the skin. It is calculated for states of debility with torpor or inactivity. It is also used as an antacid and local irritant.

1. *In dyspeptic complaints, accompanied with preternatural acidity of stomach and flatulence*, but without inflammation, a properly diluted solution of ammonia may be employed with a two-fold object—that of neutralizing the free acid, and of stimulating the stomach. It must be remembered that the healthy secretions of the stomach are of an acid nature, and that the continued use of ammonia, or any other alkali, must ultimately be attended with injurious results, more especially to the digestive functions. While, therefore, the occasional employment of alkalis may be serviceable, their constant or long-continued use must ultimately prove deleterious.

Ammonia may, under some circumstances, be employed to neutralize acids introduced into the stomach from without, as in poisoning by the mineral acids, though chalk and magnesia would be more appropriate, being less irritant. It is a valuable antidote in poisoning by hydrocyanic acid. Its beneficial operation has been ascribed to the union of the alkali with the acid, whereby hydrocyanate of ammonia is formed; but since it has been found that this salt is highly poisonous, it is evident that this explanation is not satisfactory. Some have ascribed the activity of the hydrocyanate to its decomposition by the free acids of the stomach, and the consequent evolution of free hydrocyanic acid; but this explanation is not satisfactory. I believe the efficiency of ammonia as an antidote to poisoning by hydrocyanic acid, arises from its exerting an influence of an opposite nature to that of the poison. In poisoning by the oil of bitter almonds, or other agents supposed to contain this acid, ammonia is equally serviceable. The antidote should be given by the stomach, if the patient can swallow, and the vapour should be cautiously inhaled.

2. *To produce local irritation, rubefaction, vesication, or destruction of the part.*—As a *local agent*, ammonia has been employed in a variety of diseases, sometimes as a rubefacient or irritant, sometimes as a vesicant, and occasionally as a caustic. Thus it is employed as a rubefacient in rheumatic and neuralgic pains, and as a counter irritant to relieve internal inflammations. As a local irritant, a weak solution has been injected into the vagina and uterus, to excite the catamenial discharge; but there are some objections to its use. Thus, it is a most unpleasant kind of remedy, especially to young females; moreover, the stoppage of this discharge is in many cases dependent on constitutional or remote causes, and, therefore, a topical remedy is not likely to be beneficial. Lavagna employed ten or fifteen drops of the solution, diluted with milk. The following is Nisato's formula:—

℞ Ammon. liquid. gtt. xl.; Decoct. Hordei, unc. viii.; Mucilag. Arab. unc. dimid. Misce, et fiant quatuor intra diem injectiones.

Sometimes ammonia is employed as a vesicatory; and it has two advantages over cantharides—a more speedy operation, and non-affection of the urinary organs. It may be employed in the form of ointment or solution. As a caustic, the strong solution of ammonia may be sometimes used with advantage in the bites of rabid animals.

3. *The vapour of the solution of ammonia may be inhaled* when we wish to make a powerful impression on the nervous system, as in syncope, or to prevent an attack of epilepsy. To guard against or relieve fainting, ammoniacal inhalations are very powerful and useful; their instantaneous operation is frequently astonishing. Pinel says, he once saw an attack of epilepsy prevented by this means. The patient (a watchmaker) had intimations of the approaching paroxysm from certain feelings; but he found, by inhaling the vapour of ammonia, it was frequently prevented. In the case of a confirmed epilepsy, which I was in the habit of watching for some years, I think I have also seen analogous beneficial effects. I speak doubtfully, because it is so difficult to determine, in most cases, the actual approach of the fit. It is deserving of especial notice, that ammonia is useful in three conditions of system, which, though produced by very different causes, present analogous symptoms; viz. idiopathic epilepsy—the insensibility and convulsions (? epilepsy) produced by loss of blood—and the insensibility and convulsions (? epilepsy) which poisonous doses of hydrocyanic acid give rise to. (See *Ammoniæ Sesquicarbonas.*)

In asphyxia, ammoniacal inhalations have been strongly recommended by Sage, who says, that he produced the apparent death of rabbits by immersion in water, and recovered them subsequently by the use of ammonia. A case is told us of a man who had been submerged in the Seine for twenty minutes, and who, when taken out of the water, appeared lifeless, yet by the use of ammonia recovered; and a M. Routier, a surgeon, of Amiens, is said to have restored a patient in the same way. That it may sometimes be of service I can readily believe, but it must be employed with great caution.

4. *Ammonia is given internally as a stimulant and sudorific* with manifest advantage in several cases, of which the following are illustrations:—

α. In continued fevers which have existed for some time, and where all violent action has subsided, and the brain does not appear much disordered, it is occasionally of great service. Its diaphoretic action should be promoted by diluents and warm clothing. It has an advantage over opium—that, if it do no good, it is less likely to do harm.

β. In intermittent fevers it is sometimes of advantage, given, during the cold stage, to hasten its subsidence.

γ. In the exanthemata, when the eruption has receded from the skin, and the extremities are cold, it is sometimes of great benefit, on account of its stimulant and diaphoretic properties. But in many of these cases the recession arises from, or is connected with, an inflammatory condition of the bronchial membrane, for which the usual treatment is to be adopted.

δ. In some inflammatory diseases (especially pneumonia and rheumatism,) where the violence of the vascular action has been reduced by proper evacuations, and where the habit of the patient is unfavourable to the loss of blood, ammonia has been serviceable. In combination with decoction of senega, I have found it valuable in old pulmonary affections. (See *Senega.*)

5. *In certain affections of the nervous system*, ammonia is frequently employed with the greatest benefit. Thus it has been used to relieve the cerebral disorder of intoxication. In poisoning by those cerebro-spinants commonly termed sedatives—such as foxglove, tobacco, and hydrocyanic acid, ammonia is a most valuable agent. This remedy has been supposed to possess a specific influence in relieving those disorders of the nervous system accompanied with spasmodic or convulsive symptoms; and hence it is classed among the remedies denominated *antispasmodic*. Velsen, of Cleves, has used it with advantage in delirium tremens. It was a remedy frequently tried in the malignant or Indian cholera, and occasionally procured relief, but it was not much relied on.

6. *Against the bites of poisonous animals*—as serpents and insects, ammonia is frequently employed with the best effects. There does not appear, however, any ground for the assertion of Sage, that it is a specific: in fact, Fontana declares that it is sometimes hurtful in viper bites. (For some other uses of ammonia, see *Ammoniæ Sesquicarbonas.*)

ADMINISTRATION.—It is given in doses of from five to twenty or thirty drops, properly diluted.

ANTIDOTES.—The diluted acids—as vinegar, lemon or orange juice, &c., are antidotes for ammonia. To abate the inflammatory symptoms caused by the inhalation of its vapour, blood-letting has been found serviceable.

1. **LINIMENTUM AMMONIAE**, L. E. D. (U. S.:) *Liniment of Ammonia; Volatile Liniment; Oil and Hartshorn.* (Solution of Ammonia, fʒj. [f℥ij. *D.*;] Olive Oil, fʒij. Mix and shake them well together.)—This is an *ammoniacal soap* composed of the *oleo-margarate of ammonia* mixed with some *glycerine*. (See the articles *Soap* and *Olive Oil.*) It is employed as an external stimulant and rubefacient, to relieve rheumatic and neuralgic pains, lumbago, sore throat, sprains, bruises, &c.

2. **LINIMENTUM AMMONIAE COMPOSITUM**, E.; *Compound Liniment of Ammonia.* (Stronger solution of Ammonia [sp. gr. 0·880,] fʒv.; Tincture of Camphor, f℥ij., Spirit of Rosemary, f℥j. Mix them well together. This liniment may be also made weaker for some purposes, with three fluid ounces of Tincture of Camphor and two of Spirit of Rosemary.)—These are obvious imitations of Dr. Granville's *counter-irritating* or *antinynous lotions.*[1] This liniment may be used so as to produce rubefaction, vesication, or cauterization. A piece of linen six or seven times folded, or a piece of thick and coarse flannel impregnated with this liniment, is to be applied to the part and covered with a thick towel, which is to be firmly pressed against the part. If rubefaction merely be desired, the application is continued for from one to six or eight minutes; but from ten to twelve minutes are necessary to excite vesication and cauterization. In painful and spasmodic affections, as neuralgia, cramp, &c.; in rheumatism, lumbago, and swollen and painful affections of the joints; in headach, sore throat, sprains,

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[1] *Lancet*, October 27, 1838; and *Brit. and Foreign Med. Review*, vol. vii. p. 292.—Also Dr. Granville's work, entitled *Counter-irritation, its Principles and Practice, illustrated by one hundred cases of the most painful and important Diseases effectually cured by external applications.* Lond. 1838.

and many other cases, benefit may be obtained from a powerful and speedy counter-irritant like this, as stated by Dr. Granville.

3. **UNGUENTUM AMMONIAE**; *Liparolé d'Ammoniaque; Pommade Ammoniacale de Gondret; Gondret's Ammoniacal Ointment.*—The formula for this, as given by Soubeiran, (*Nouveau Traité de Pharmacie*, t. ii. p. 302, 2^{nde} éd. Paris, 1840.) is as follows:—Suet one part, Hog's Lard one part, and Strong Solution of Ammonia two parts. In Gondret's[1] work, however, the following formula is given:—Hog's Lard, ℥vij., Oil of Sweet Almonds, ʒiss., and Strong Liquid Ammonia, from ʒv. to ʒvj. Melt the lard, mix it with the oil, and pour them into a wide-mouthed bottle with a ground glass stopper; then add the ammonia, close the bottle, mix the contents together by shaking, and keep the mixture in a cool place.—This ointment, rubbed on the skin and covered by a compress, speedily produces vesication. Without the compress it causes rubefaction. It is a very useful rubefacient, vesicant, and counter-irritant.

4. **TINCTURA AMMONIAE COMPOSITA**, L. *Spiritus Ammoniæ succinatus.* (Mastic, ʒij.; Rectified Spirit, f℥ix.; Oil of Lavender, ♏xiv.; Oil of Amber, ♏iv.; Stronger Solution of Ammonia, Oj. Macerate the Mastic in the Spirit, that it may be dissolved, and pour off the clear tincture; then add the other ingredients, and shake them all together.)—This liquid is milky owing to the separation of the mastic from its spirituous solution by ammonia. It is commonly called *Eau de Luce* (*Aqua Luciæ*,) after an apothecary at Lille. M. B. Jussieu (*Histoire de l'Académie Royale des Sciences.* Année 1747, p. 54.) gave it to one of his pupils who had been bitten by a viper; and, as the patient recovered, the remedy acquired considerable celebrity as a counter-poison to the bites of venomous snakes. But Fontana (*Treatise on the Venom of the Viper*, vol. ii. Lond. 1787.) has shown, that ammonia (its active principle) does not possess any powers of this kind. The compound tincture of ammonia is a powerful antispasmodic stimulant, and is now principally employed as an antihysteric, in doses of from ten to thirty or forty minims. It has also been used as a stimulating embrocation.

7. AMMO'NIÆ CAR'BONAS.—CARBONATE OF AMMONIA.

History.—Both solid and liquid compounds of ammonia and carbonic acid have been known for several centuries. Raymond Lully, in the 13th century, was acquainted with the impure solution of carbonate of ammonia obtained from putrid urine; and it is probable that the Arabians had known it long before. Basil Valentine (*Chymische Schriften*, Ander-Theile, S. 392. Hamb. 1677.) speaks of the *spiritus salis urinæ.*

Natural History (see *Ammonia*, p. 272.)—Carbonate of Ammonia is formed during the putrefaction or destructive distillation of those organic substances which contain nitrogen. It is a constituent of rain water, (see p. 243.)

Preparation.—Anhydrous neutral carbonate of ammonia can only be obtained by bringing together dry carbonic acid and ammoniacal gases. It is not employed in medicine.

Hydrated neutral carbonate of ammonia is the first, and, therefore, the most volatile, of the solid products which appear in the distillation of the commercial hydrated sesquicarbonate of ammonia. If hydrated sesquicarbonate of ammonia be digested in a small quantity of water, we obtain a solution of a neutral carbonate of ammonia, mixed, however, with a little of the bicarbonate.

The same neutral carbonate is obtained when a mixture of sal ammoniac and carbonate of either soda or potash is submitted to distillation with water; and on this principle several liquid preparations (presently to be mentioned) of this neutral salt are directed to be prepared in the Pharmacopœia. One equivalent or 54 parts of the hydrochlorate of ammonia react on one equivalent or 70 parts of car-

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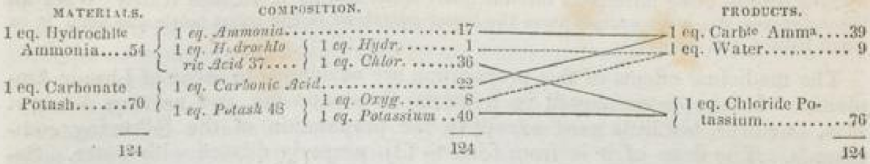
[1] *Traité Théorique et Pratique de la Dérivation contre les Affections les plus communes en général, telle la Pléthore, l'Inflammation, l'Hémorrhagie, &c.* Paris, 1837. Reviewed in *Brit. and For. Medical Review*, vol. vii. p. 56.

bonate of potash, and yield one equivalent or 76 parts of chloride of potassium, one equivalent or 9 parts of water, and one equivalent or 39 parts of carbonate of ammonia.



Bone spirit, obtained by the destructive distillation of bones, contains neutral carbonate of ammonia in solution with animal empyreumatic oil.

Properties.—Hydrated neutral carbonate of ammonia is a crystalline salt, having an ammoniacal odour, but weaker than that of a solution of caustic ammonia.

Characteristics.—Its solution, yields, on the addition of chloride of barium, a white precipitate (*carbonate of baryta:*) and no farther precipitate is obtained by the farther addition of caustic ammonia to the mixture. This character distinguishes the neutral carbonate from the sub- and super-carbonates of ammonia, (see *Hydrated Sesquicarbonate* and *Bicarbonate of Ammonia.*)

Composition.—The hydrated neutral carbonate of ammonia has, according to Rose, the following composition:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Rose.*
Ammonia	2	34	39·080	39·27
Carbonic Acid	2	44	50·575	50·09
Water	1	9	10·345	10·64
Hydrated Carbonate of Ammonia	1	87	100·000	100·00

Or	*Atoms.*	*Eq. Wt.*	*Per Cent.*
Carbonate of Ammonia	1	39	44·83
Carb. of Oxide of Ammonium	1	48	55·17
	1	87	100·00

Physiological Effects and Uses.—The effects of carbonate of ammonia are similar to, but somewhat milder than, those of caustic ammonia. The neutral carbonate is more powerful than the hydrated sesquicarbonate, and still more so than the bicarbonate of ammonia. In the solid form it is not employed in medicine. Several officinal preparations, however, owe their medicinal activity to it.

1. **SPIRITUS AMMONIAE**, L. E. D. (U. S.) *Spirit of Ammonia.*—Prepared according to the London and Dublin Pharmacopœias, this is a solution of carbonate of ammonia in rectified spirit; but according to the Edinburgh Pharmacopœia it is a solution of ammoniacal gas in spirit. The following are the formulæ of the three colleges:—

The *London College* orders Hydrochlorate of Ammonia, ℥x.; Carbonate of Potash, ℥xvj. Rectified Spirit; Water; of each Oiij. Mix, and let three pints distil.—In this process double decomposition takes place (as above explained,) and the carbonate of ammonia, which is produced, distils over with the spirit, in which the greater part of it dissolves; the remainder being deposited in an imperfectly crystalline state.

The *Dublin College* directs [Sesqui-] Carbonate of Ammonia, coarsely powdered, ℥iijss. to be dissolved, with a medium heat, in Rectified Spirit, Oiij. [*wine measure.*]—During the solution in the heated spirit, the sesqui-carbonate evolves carbonic acid gas, and is reduced to the state of carbonate of ammonia, of which about 30 grains are taken up by each ounce measure of the spirit.

The *Edinburgh College* orders Rectified Spirit, Oij. and fʒij; Fresh-burnt Lime, ℥xij.; Muriate of Ammonia, in very fine powder, ℥viij.; Water, f℥viss. Let the lime be slaked with the water in an iron or earthenware vessel, and cover the vessel till the powder be cold; mix the lime and muriate of ammonia quickly and thoroughly in a mortar, and transfer the mixture at once into a glass retort; adapt to the retort a tube which passes nearly to the bottom of a bottle containing the rectified spirit; heat the retort in a sand-bath gradually, so long as any thing passes over, preserving the bottle cool. The bottle should be large enough to contain one-half more than the spirit used.—In this process we obtain, by the mutual reaction of the sal ammoniac and lime, (See p. 271.) ammoniacal gas, which passes over, and is dissolved in the spirit contained in the receiver.

(*The U. S. Pharmocopœia* directs Muriate of Ammonia in fine powder; Lime, each a pound; Alcohol, twenty fluid ounces; Water, nine fluid ounces. Slake the lime with the water; mix it with the Muriate of Ammonia, and proceed in the manner directed for solution of Ammonia, the Alcohol being introduced into the quart bottle instead of distilled Water. When all the Ammonia has come over, remove the liquor contained in the quart bottle and keep it in small bottles well stopped.)

The medicinal effects of this preparation are analogous to those of Liquor Ammoniæ. It may be employed in hysteria, flatulent colic, and nervous debility. It is, however, but little used except in the preparation of the following compounds. The dose of it is from fʒss. to fʒj. properly diluted with water. Saturated with camphor it forms a highly stimulating liniment.

2. **SPIRITUS AMMONIAE FOETIDUS**, L. E. D. *Fetid Spirit of Ammonia.*—In this, as in the preceding preparation, a difference exists in the formulæ of the British Colleges. The London and Dublin Colleges use a solution of carbonate of ammonia, while the Edinburgh College employs a solution of caustic ammonia.

The formula of the *London College* is the same as that for Spiritus Ammoniæ, *L.;* except that five ounces of Asafœtida are put into the retort with the other ingredients.

The *Dublin College* orders Asafœtida ℥iss. to be macerated for three days in Spirit of Ammonia, Oij. [*wine measure,*] shaking occasionally; then pour off the clear liquor, and distil a pint and a-half.

The *Edinburgh College* employs Spirit of Ammonia, f℥xss,; Asafœtida, ℥ss, Break the Asafœtida into small fragments; digest it in the spirit for twelve hours; and distil over ten fluid ounces and a-half by means of a vapour-bath heat.

This preparation is a very unnecessary one. It is merely a solution of the volatile oil of the asafœtida in spirit of ammonia; for which a mixture of tincture of asafœtida and spirit of ammonia may be conveniently and more efficaciously substituted. It is a colourless, pungent, and fetid liquor, which becomes brownish by age. It is employed in hysteria, in doses of from half a drachm to a drachm in water.

3. **SPIRITUS AMMONIAE AROMATICUS**, L. E. D. (U. S.) *Spirit of Sal Volatile.*—The preparation of the London and Dublin Pharmacopœias is a solution of the carbonate of ammonia; but that of the Edinburgh Pharmacopœia contains caustic ammonia.

The *London College* gives the following formula:—Hydrochlorate of Ammonia, ℥v.; Carbonate of Potash, ℥viij.; Cinnamon, bruised; Cloves, bruised, of each ʒij.; Lemon Peel, ℥iv.; Rectified Spirit; Water, of each, Oiv. Mix them, and let six pints distil.—In this process double decomposition takes place, as already noticed, and the carbonate of ammonia distils over with the spirit and part of the water flavoured by the essential oils of the aromatics used.

(The same formula has been adopted by the U. S. Pharmacopœia, which directs, the distillation over of seven pints and a-half.)

The *Dublin College* orders spirit of Ammonia, Oij. [*wine measure;*] Essential Oil of Lemons, ʒij.; Nutmegs bruised, ℥ss.; Cinnamon Bark, bruised, ʒiij. Macerate in a close vessel for three days, shaking occasionally; then distil a pint and a half.

The *Edinburgh College* orders of Spirit of Ammonia, f℥viij.; Volatile Oil of Lemon-peel, fʒj.; Volatile Oil of Rosemary, fʒiss. Dissolve the oils in the spirit by agitation.

This preparation on account of its more agreeable taste and smell, is usually preferred to the Spiritus Ammoniæ above noticed, than which it is somewhat weaker. It is frequently employed in languors, faintings, hysteria, flatulent colic, and nervous debility, in doses of from fʒss. to fʒij. properly diluted with water.

8. AMMO'NIÆ SESQUICAR'BONAS, *L.*—SESQUICARBONATE OF AMMONIA, *E.*

(Ammoniæ Carbonas, *E. D.*) (U. S.)

History.—This salt was probably known to Raymond Lully; but until late years it has been confounded with the other carbonates of ammonia. It is frequently denominated *subcarbonate of ammonia*, *volatile*, or *smelling salts*, or *baker's salt*. The last appellation has been given to it because of its use by bakers, as a substitute for yeast, in the manufacture of some of the finer kinds of bread.

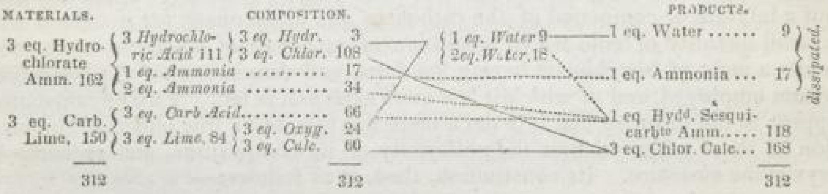
It is probable that the terms *sal alkali volatile siccum* seu *urinosum*, *sal volatile salis ammoniaci*, and *sal volatile cornu cervi*, applied to this rather than any other carbonate of ammonia.

Natural History.—See *Ammonia* (p. 271,) and *Ammoniæ Carbonas* (p. 280.)

Preparation.—Manufacturers prepare it by submitting to sublimation a mixture of sal ammoniac or impure sulphate of ammonia and chalk. A few years since, it was extensively made at Messrs. Bush & Co.'s Bow Common. The retorts in which the sublimation was effected, were of cast iron, and similar in shape and size to those employed in the manufacture of coal gas. Each retort communicated posteriorly with a leaden receiver, with which was connected a second receiver of the same size and shape. The receivers had the form of square prisms placed endways, and were supported in a wooden frame-work. The impure sesquicarbonate thus obtained was contaminated with tar or oily matter, and deposited a dark carbonaceous matter when dissolved in acids. It was refined in iron pots, surmounted with leaden heads, and heated by the flue of the retort furnace. A little water is introduced into the pots to render the sesquicarbonate translucent. In another manufactory, which I have inspected, the pots are heated by a water-bath; a temperature of 150° F. being, I am informed, sufficient for this process.

All the British Colleges give formulæ for the preparation of this salt. The *London* and *Edinburgh Colleges* order of Hydrochlorate of Ammonia, ℔j., and Chalk ℔iss. These are to be rubbed separately to powder, then mixed, and submitted to sublimation with a heat gradually increased. The *Dublin College* orders equal parts of Muriate of Ammonia, and dried Carbonate of Soda.

In this process three equivalents or 162 parts of sal ammoniac react on three equivalents or 150 parts of carbonate of lime, and produce an equivalent or 118 parts of the hydrated sesquicarbonate of ammonia, three equivalents or 168 parts of chloride of calcium, one equivalent or 17 parts of ammonia, and one equivalent or 9 parts of water. The chloride of calcium is left in the retort, the hydrated sesquicarbonate of ammonia is sublimed, while the ammonia and the water are dissipated.



It appears from some experiments, presently to be noticed, that the compound called hydrated sesquicarbonate of ammonia is a double salt, consisting of one equivalent of anhydrous carbonate of ammonia (NH^3, CO^2) and one equivalent of hydrated bicarbonate of ammonia (NH^3, $2\,CO^2$, $2\,HO$.) Now in general, when two neutral salts react on each other, the resulting compounds are also neutral; and, therefore, by the mutual action of 3 equivalents of hydrochlorate of ammonia and 3 equivalents of carbonate of lime, the calculated products should be 3 equivalents of hydrated neutral carbonate of ammonia (NH^3, CO^2, HO,) called hypothetically carbonate of the oxide of ammonium, and 3 equivalents of chloride of calcium. But it appears from Rose's experiments (Taylor's *Scientific Memoirs*, vol. ii.) that such a hydrated neutral carbonate of ammonia does not exist *per se*. Hence at the commencement of the heating process ammoniacal gas escapes with just so much water as is sufficient to form the hypothetical oxide of ammonium.

Hydrated sesquicarbonate of ammonia cannot be re-sublimed unchanged. Hence in the process of refining, its constitution changes; every two equivalents lose an equivalent of carbonic acid, and the product is a hydrated $\frac{5}{4}$ carbonate of ammonia.

MATERIAL.	COMPOSITION.		PRODUCTS.
2 eq. Hydrd. Sesquicarbonate Ammonia 236	*1 eq. Carbonic Acid*	22	1 eq. Carbonic Acid 22
	5 eq. Carbonic Acid	110	1 eq Hydrated $\frac{5}{4}$ Carbte. of Ammonia 214
	4 eq. Ammonia	68	
	4 eq. Water	36	
236		236	236

Properties.—Hydrated sesquicarbonate of ammonia is met with in the form of fibrous, white, translucent cakes, about two inches thick. When exposed to the air it evolves carbonate of ammonia, and is converted into bicarbonate of ammonia; so that its vapour has a pungent odour, and strongly reddens turmeric paper. The resulting hydrated bicarbonate is opaque, pulverulent, and much less pungent, from which it has been termed *mild carbonate of ammonia*. The sesquicarbonate is soluble in four times its weight of cold water; but boiling water or alcohol decomposes it, with the evolution of carbonic acid.

Characteristics.—As an ammoniacal salt, this substance is recognised by its odour, its fugacious action on turmeric paper, and by its action on the salts of copper, bichloride of platinum, and bichloride of mercury (see tests for ammonia, p. 272.) As a carbonate it is known by its solution yielding a white precipitate (*carbonate of baryta*) with the chloride of barium: the clear liquor from which this precipitate has subsided, yields a farther precipitate on the addition of caustic ammonia. By this last character the sesquicarbonate is distinguished from the neutral carbonate.

Composition.—This salt consists, according to Mr. Phillips, (*Quarterly Journal of Science*, vol. vii. p. 294.) Dr. Thomson, and Rose, of carbonic acid, ammonia, and water, in the following proportions:—

	Atoms.	*Eq. Wt.*	*Per Centage.*	*R. Phillips.*
Carbonic Acid	3	66	55·93	54·2
Ammonia	2	34	28·81	29·3
Water	2	18	15·26	16·5
Hydrated Sesquicarbonate of Ammonia	1	118	100·00	100·0

It appears, however, from the observations of Dalton (*Memoirs of the Literary and Philosophical Society of Manchester*, 2nd Ser. vol. iii. p. 18.) and Scanlan, (*Athenæum* for 1838, p. 596.) that it is not a single salt or true sesquicarbonate, but a mixture or compound of the carbonate and bicarbonate; for if treated with a small quantity of cold water, a solution of carbonate of ammonia is obtained, while a mass of bicarbonate having the form and dimensions of the sesquicarbonate employed, and of which it is a mere skeleton, is left. Two circumstances appear to me to prove that it is not a mere mixture, but a true chemical combination of these salts; viz. first the uniformity of its composition, and secondly its crystalline structure. Its constitution, then, is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*
Anhydrous Carbonate of Ammonia	1	39	33·05
Hydrated Bicarbonate of Ammonia	1	79	66·95
Hydrated Sesquicarbonate of Ammonia	1	118	100·00

Impurity.—The hydrated sesquicarbonate of ammonia of commerce is sometimes contaminated with empyreumatic oil, and in this state it yields a more or less deeply-coloured, or even blackish, solution when dissolved in dilute acid. The pure salt, on the other hand, yields a colourless solution, and leaves no residuum when heated on platinum or glass. It is translucent and crystalline; but when exposed to the air it evolves carbonate of ammonia, and becomes opaque, pulverulent, and less pungent: in this state it consists principally of bicarbonate of ammonia. Lastly, its aqueous solution, saturated with pure nitric acid, gives no precipitate with solution of chloride of barium or of nitrate of silver; for a precipitate with the first of these substances would indicate the presence of a sulphate, with the second a chloride.

Physiological Effects. *α. On Animals.*—The principal experimenters with this salt are Seybert, Orfila, and Gaspard, on dogs, and Wibmer on man. Seybert (Quoted by Wibmer, *Die Wirkung*, &c.) injected in one experiment fifteen grains, in a second twenty-five grains; and in a third experiment forty-five grains of this salt, dissolved in a little water, into the crural vein of a dog: the animal appeared to suffer great pain; the frequency of the heart's action was increased, the respiration became difficult, and violent convulsions came on; but in all these cases perfect recovery took place. The blood, drawn after the injection, had its natural colour, odour, and consistence. Orfila (*Toxicol. Générale.*) found that two drachms and a-half of the salt, given to a dog, caused gastric inflammation, with tetanic convulsions; the body ultimately becoming curved with the head forcibly bent backwards. Gaspard, quoted by Wibmer, (*Die Wirkung*, &c.) killed a young pig, of three weeks old, by injecting twenty-four drops of (a solution of) carbonate of ammonia in an ounce of water into the veins. Death occurred in nine hours.

β. On Man.—Wibmer found that a grain and a-half of this salt produced on himself no remarkable effect; three grains increased the frequency of the pulse from 68 to 72 beats per minute, with throbbing headach. In other experiments, in which he took from six to twelve grains (in some repeating the dose at short intervals,) the effects were usually, but not constantly, increased frequency of pulse, with disorder of brain, manifested by the pain, heaviness, throbbing, &c. In one instance, he says, disposition to cough, and increased secretion of bronchial mucus, were remarkable. To an epileptic patient (a female) in the London Hospital, I gave fifteen grains of this salt three times a day for two months, without any apparent injury. The fits, which previously had occurred at stated periods, were suspended during the time the patient was under the influence of the medicine. Huxham (*Essay on Fevers*, pp. 48 and 308, 3d edit. 1757.) has mentioned a remarkable case illustrative of the ill effects resulting from the long-continued use of this salt.

> "I had lately under my care," he observes, "a gentleman of fortune and family, who so habituated himself to the use of vast quantities of the volatile salts, that at length he could eat them in a very astonishing manner, as other people eat sugar and caraway seeds. The consequence was that he brought on a hectic fever, vast hæmorrhages from the intestines, nose, and gums; every one of his teeth dropped out, and he could eat nothing solid; he wasted vastly in his flesh, and his muscles became as soft and flabby as those of a new born infant; and he broke out all over his body in pustules. His urine was always excessively high coloured, turbid, and very fetid. He was at last persuaded to leave off this pernicious custom; but he had so effectually ruined his constitution, that, though he rubbed on in a miserable manner for several months, he died, and in the highest degree, of marasmus. And I am persuaded he would have died much sooner, had he not constantly drank very freely of the most fine and generous wines, and daily used large quantities of asses' milk, and anti-scorbutic juices, acidulated with juice of lemon."

The general action of this salt is similar to that of caustic ammonia, already noticed. Its topical operation, however, is less intense; for combination with carbonic acid diminishes the local action of ammonia in proportion to the quantity of acid present.

In small doses it proves antacid, stimulant, and sudorific. By repeated use it operates as a liquefacient (see p. 194,) like the other alkalis, though much less intensely so. In doses of thirty grains or more it is apt to occasion vomiting. The effects of an over-dose are abdominal pains, and other symptoms of inflammation, convulsions, and other phenomena indicative of its action on the nervous system.

Uses.—It is used in the same cases and under the same regulations as the solution of ammonia, to which I must refer the reader (see p. 277.)

Recently this salt has been recommended, by Dr. Barlow, (*Guy's Hospital*

Reports, vol. v.) in *diabetes*, several cases of which are said to have been relieved, if not cured, by it. I regret that I cannot confirm Dr. Barlow's favourable notice of it. In one case (that of a man, an out-patient at the London Hospital) it has, in my hands, failed to give any relief, after a prolonged trial.

It has been employed with excellent effect in some cases of *scrofula*.[1] It is best adapted for those cases attended with a languid circulation and a dry state of skin.

It is frequently employed for the preparation of effervescing draughts. The following are the relative proportions of acid and base to be used:—

20 grains of Sesquicarbonate of Ammonia require............................	6	fluid-drachms of Lemon Juice, or
	24	grains of crystallized Citric Acid, or
	25½	grains of crystallized Tartaric Acid.

The citrate and tartrate of ammonia thus obtained are useful remedies in febrile cases, where the object is to promote cutaneous circulation and exhalation.

Full doses of this salt have been employed in *paralysis*, to occasion vomiting.

Mixed with some aromatic oil (as the oil of bergamot or lavender,) it is used as *a smelling salt*, against syncope, hysteria, &c.

As a topical agent it has been employed in aqueous solution, or mixed with oil to form an imperfect kind of soap, or made into ointment with lard. Its operation in these cases is that of a topical stimulant and rubefacient. It proves useful in rheumatic pains, sprains, &c.

ADMINISTRATION.—As a stimulant and diaphoretic, it is used in doses of from five grains to a scruple, exhibited either in the form of pill or of solution. As an emetic, the dose is 30 grains, properly diluted, and repeated if necessary.

ANTIDOTES.—(See *Ammonia*, p. 279.)

1. **LIQUOR AMMONIAE SESQUICARBONATIS**, L. *Ammoniæ Carbonatis Aqua*, E. D. (Sesquicarbonate of Ammonia, ℥iv. [4 parts, *D.*;] Distilled Water, Oj. [15 parts, *D.*] Dissolve and filter.)—By exposure to the air, this solution loses its pungency by the formation of bicarbonate of ammonia. It may be given internally in doses of from fʒss. to fʒiss., or even fʒij. properly diluted. It is employed in the preparation of Ferri Potassio-tartras, *Ph. L.*, and is a constituent of the following liniment:—

2. **LINIMENTUM AMMONIAE SESQUICARBONATIS**, L. *Liniment of Sesquicarbonate of Ammonia.* (Solution of Sesquicarbonate of Ammonia, f℥j.; Olive Oil, f℥iij. Shake them together until they are mixed.)—Oil and sesquicarbonate of ammonia form a soap, but owing to the presence of the carbonic acid, it is of an imperfect kind. Its effects and uses are analogous to the *Linimentum Ammoniæ* before mentioned (p. 279.)

9. AMMO'NIÆ BICAR'BONAS, *D.*—BICARBONATE OF AMMONIA.

HISTORY.—This salt was formed by Berthollet, and hence it is sometimes termed *Berthollet's neutral carbonate of ammonia.*

PREPARATION.—The directions of the Dublin College for its preparation, are as follows:—

"Take of Water of Carbonate of Ammonia any required quantity. In a suitable apparatus let the water be exposed, until the alkali is saturated, to the stream of Carbonic Acid Gas which escapes during the solution of white marble in diluted Muriatic Acid. Then let it rest, and let crystals form, which are to be dried without heat, and preserved in a close vessel."

Bicarbonate of Ammonia is also formed by keeping the common sesquicarbonate of ammonia in imperfectly closed vessels. Another mode of obtaining it

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[1] *An Essay on Scrofula; in which an Account of the Effect of the Ammoniæ Carbonas, as a Remedy in that Disease, is submitted to the Profession.* By Charles Armstrong, M.D. Lond. 1812.

is by digesting water on the sesquicarbonate: the more soluble carbonate is dissolved, leaving the less soluble bicarbonate (see p. 284.)

Properties.—The crystals of this salt belong to the *right rhombic system.* (See Rose's paper, in Taylor's *Scientific Memoirs*, vol. ii.) Their smell and taste are very faintly ammoniacal. This salt is less soluble in water than the preceding carbonates; for it requires eight parts of cold water to dissolve it. The solution, by exposure to the air, loses part of its carbonic acid, especially if it be heated.

Characteristics.—It is distinguished from the before-mentioned carbonates by having scarcely any ammoniacal odour. Its solution at first occasions no precipitate with chloride of barium or chloride of calcium (unless caustic ammonia be added:) after a short time, however, the mixture evolves carbonic acid, and a white earthy carbonate is precipitated.

Composition.—The composition of this salt is as follows:—

	Atoms.	*Eq. Wt.*	*Per Cent.*	*Phillips.*	*Rose.*		*Vols.*
Ammonia	1	17	21·5	21·16	21·39	Ammoniacal gas	2
Carbonic Acid	2	44	55·7	55·50	56·09	Carbonic Acid gas	2
Water	2	18	22·8	23·34	22·52	Aqueous Vapour	2
Crystallized Bicarbonate of Ammonia	1	79	100·0	100·00	100·00		

Physiological Effects and Uses.—The operation and uses of this salt are analogous to those of the preceding compounds of ammonia. It is termed diaphoretic, antispasmodic, and antacid. Being less caustic, it is more palatable than the other carbonates. It may be employed to form effervescing medicines. About 18 grs. of Citric, or 19 grs. of Tartaric Acid, are required to saturate ℈j. of this salt.

Administration.—The dose of it is from six to twenty-four grains, dissolved in *cold* water.

10. AMMO'NIÆ HYDROCHLO'RAS, *L.*—HYDROCHLORATE OF AMMONIA, *E.*

(Ammoniæ Murias, *E. D.*) (U. S.)

History.—The early history of this salt is involved in considerable obscurity; for though the term *sal ammoniacus* (αλς αμμωνικος) is met with in several old writers, it is believed, by the erudite Beckmann (*History of Inventions*, vol. iv. p. 306. Lond. 1814.) as well as by others, to refer to rock-salt. The first distinct notice of hydrochlorate of ammonia is to be met with in Geber, who was acquainted with the mode of purifying it by sublimation. But as my friend Dr. Royle observes, (*Essay on the Antiquity of Hindoo Medicine*, p. 41. Lond. 1837.) this salt "must have been familiar to the Hindoos ever since they have burnt bricks, as they now do, with the manure of animals; as some may usually be found crystallized at the unburnt extremity of the kiln."

The substance, whatever its nature may be, which the ancients termed sal ammoniac, derived its name from *Ammonia*, the name of a district of Libya where the oracle of Jupiter Ammon was situated. This district took its name from αμμος, *sand*, on account of the sandy nature of its soil. Herodotus (Lib. iv., [*Melpomene*,] cap. 181 et 182.) mentions the salt found in this district.

Synonymes.—Few substances have had so many synonymes as this salt. Besides those above given, the most familiar are, *sal ammoniac* or *muriate of ammonia.* On the ammonium hypothesis it is called *chloride of ammonium*, ($NH,^4$ Cl.,) while, according to Dr. Kane, it is *chloro-amidide of hydrogen* ($NH,^2$ H, H Cl.)[1]

Natural History:—(See *Ammonia*, p 271.)

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[1] For the alchymical names of this substance, See Dr. T. Thomson's *History of Chemistry*, vol. i. p. 125. Lond. 1830; and Parr's *Medical Dictionary*, art. *Armoniacus.*

Preparation.—In Egypt, Sal Ammoniac is obtained by sublimation from the soot afforded by the combustion of camel's dung.[1]

It is probable that the muriatic acid or chlorine of this salt is derived from the common salt on which these animals feed; for Chaptal (*Elements of Chemistry*, vol. i. p. 262. Lond. 1791.) says that he could only procure sal ammoniac from the soot of cow-dung and that of horses while these animals continued to live on marine plants.

Some years ago this salt was manufactured in London from the soot of coals. At the latter end of the last century it was made in Paris by the union of ammoniacal vapour (obtained by the decomposition of animal matters, in iron cylinders placed in a furnace) with muriatic acid gas. (See *Journal de Physique* for 1794.—Also Parkes, *op. supra cit.*)

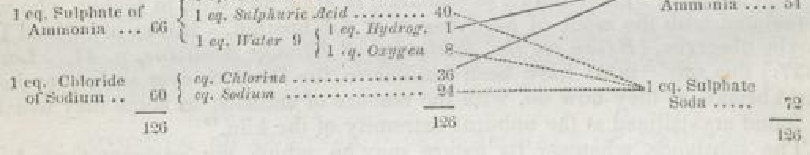
At the present time sal ammoniac is manufactured in this country from the impure ammoniacal liquors obtained as secondary products in the manufacture of coal gas and animal charcoal.

1. Manufacture of Sal Ammoniac from Coals.—In the manufacture of coal gas, coal is submitted to distillation in iron retorts, and the volatile matters obtained are conveyed to a condensing vessel or refrigeratory, in which are deposited tar and an ammoniacal liquor.

This ammoniacal liquor (commonly termed *gas liquor*) contains several salts of ammonia—such as carbonate, hydrocyanate, sulphate, and hydrosulphate. It is usually sold to sal ammoniac manufacturers, who reside in the outskirts of the metropolis. The precise mode of proceeding, to convert it into sal ammoniac, varies according to circumstances. Sometimes sulphuric acid is added, and the liquor evaporated, by which brown crystals of sulphate of ammonia are obtained. This salt is then mixed with chloride of sodium, and submitted to distillation in iron pots lined with clay, to which is adopted a leaden dome or head, having an aperture or open cylindrical tube, which can be closed or opened according to circumstances.

A few years since I saw this process in operation at the Westminster Gas-works. On examining the clay removed from the pots after the operation, I discovered small, but perfect and beautiful, crystals of the bisulphuret of iron, which had been formed during the process.

Every equivalent or 66 parts of sulphate of ammonia react on one equivalent or 60 parts of chloride of sodium, and yield one equivalent or 54 parts of sal ammoniac, and one equivalent or 72 parts of sulphate of soda.



In some cases the gas liquor is saturated with hydrochloric acid, and the brown crystals of hydrochlorate of ammonia obtained by evaporation are purified by sublimation.

As a cheap substitute for hydrochloric acid, manufacturers sometimes employ chloride of calcium.[2] This proceeding I have seen adopted at the manufactory of Messrs. Bush & Co., Bow Common. The process has been described by my friend and former pupil, Dr. G. H. Jackson. (*London Medical Gazette*, Aug. 4, 1839.)

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[1] A very full and complete description of the process, with illustrative plates, will be found in the splendid *Description de l'Egypte*. Etat Moderne, tom. i. p. 413. Paris, 1809; Planches ii. and xxiv. Arts et Métiers. See also Parke's *Chemical Essays*, ed 2d, vol. ii. p. 437. Lond. 1823.

[2] The chloride of calcium used in the above process is a secondary product obtained, I am informed, from salt-works. It contains the chlorides of sodium and magnesium.

To the gas liquor, chloride of calcium is added, when a copious precipitation of carbonate of lime takes place, muriate of ammonia being left in solution. The whole of this is put into a tub, having holes in the bottom to allow the solution to drain through, leaving the solid particles behind. This solution is evaporated at a gentle temperature in iron tanks, when it yields impure crystals of muriate of ammonia, of a brownish colour. The salt is then dried, and the water of crystallization driven off in a long iron vessel, very similar to a sand-bath. It is now placed in an iron subliming pot, (previously coated to the extent of from one to five inches in thickness, with a composition of common clay, sand, and charcoal,) capable of holding about 5 cwts. This is covered by a dome of lead, with an aperture at the top, in which a stopper is placed, by the removal and appearance of which the manufacturer judges of the progress of the sublimation. A gentle fire is kept up under the subliming pot for seven or eight days, when the dome having cooled down, and the sal ammoniac somewhat contracted, so as to loosen from the sides, the dome is thrown off from the iron pot, and about 2 or 3 cwts. of white, semi-transparent, muriate of ammonia are knocked off in cakes.

I have seen cakes of sal ammoniac, made at Messrs. Bush & Co's by this process, weighing between 5 and 6 cwts. each; and I am informed that they sometimes weigh 1000 lbs. each. They are discoloured on their convex surface, (in contact with the leaden dome,) and are, therefore, carefully scraped before being sent out.

The gray salt scraped from the exterior of the cakes consists of, or at least yields, hydrochloric acid, ammonia, and lead. A solution of the purified salt yields no iodide of lead on the addition of iodide of potassium, but affords a black precipitate (sulphuret of lead) when sulphuretted hydrogen gas is passed through it. It is probably a double chloride of lead and ammonium. (Dr. Jackson, *Ibid.*)

Yellow or brownish streaks or bands are frequently observed in the cakes of sal ammoniac. These are ascribed by the manufacturers to the neglect of the workmen who, falling asleep during the night, allow the fire to go down considerably, and then suddenly raise the heat, by which chloride of iron is sublimed in combination with sal ammoniac.

For several years I have been accustomed to show, in the lecture-room, that a solution of these yellow bands in water gives no traces of iron on the addition of ferrocyanide of potassium, until a few drops of nitric acid be added, when a copious blue precipitate is formed; and I, therefore, inferred that this yellow matter was a double chloride of iron and ammonium. My opinion has been fully confirmed by the experiments of Dr. G. H. Jackson.

2. Manufacture of Sal Ammoniac from Bones.—Animal charcoal is extensively manufactured from bones for the use of sugar-refiners; and during the process an ammoniacal liquor (called *bone spirit*) is obtained as a secondary product. The operation is thus conducted.

Bones are first boiled to remove the fatty matter which is used in soap-making. The larger and finer pieces are then selected for the manufacture of buttons, handles of knives and tooth-brushes, &c.: while the smaller and refuse portions are sold as manure. The remainder is submitted to distillation.

The stills or retorts are sometimes made of cast iron, and in shape and size resemble those used at gas-works. Formerly they were placed horizontally in the furnace,[1] and the volatile matters were conveyed away by a pipe opening into the ends of the retorts. To facilitate the speedy removal of the charcoal, they are sometimes placed obliquely in the furnace: the bones are introduced at the upper end, and the charcoal is removed from the lower end;—while the volatile matters are conveyed away by a side pipe. But these retorts are considered inferior to the vertical ones, on account of the facility and speed with which the latter can be charged and discharged. The vertical stills or retorts are made of cast iron or of Welch bricks; the latter, I am informed, are preferable. In a large manufactory of animal charcoal in this metropolis, the shape of the retort

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[1] See Ure's *Dictionary of Arts and Manufactures*, p. 1081, figs. 954 and 955. Lond. 1839.

is that of a right rectangular prism; its height being twenty feet, its length about three feet, and its breadth two feet. It is closed at the top by a moveable iron plate, secured by a screw bolt. It is closed below by a double trap-door opening underground. Around the retort is a furnace of brickwork, whose shape is that of a truncated pyramid.

The bones are introduced at the upper end of the retort. The volatile products are conveyed away by an iron pipe. After passing through a cistern they are conveyed to a series of receivers, where the brown ammoniacal liquor (*bone spirit*) and the empyreumatic oil (*animal oil*) are deposited. The non-condensable portion is a fetid inflammable gas: this, after passing through water contained in the second receiver, is conveyed into a chimney, or is burned. The solid residue in the retort is removed, while red hot, through the lower and underground end of the retort, into wrought-iron canisters, which are instantly closed by iron covers, luted to make them air-tight, and then raised to the surface by a crane. When cold it is ground, and sold as *animal bone*, or *ivory black*.

The products of this operation are easily accounted for. When bones are heated, their cartilaginous or gelatinous portion undergoes decomposition, and its elements (carbon, hydrogen, nitrogen, and oxygen) enter into new combinations. Some of the oxygen and hydrogen unite to form *water*. Carbon and oxygen, combining in different proportions, furnish *carbonic oxide* and *acid*. Carbon with hydrogen forms *carbohydrogen*; while nitrogen uniting with hydrogen produces *ammonia*, which, with some carbonic acid, forms *carbonate of ammonia*. The *empyreumatic* or *animal oil* consists of carbon, hydrogen, and oxygen, with probably some nitrogen.

Manufacturers of animal charcoal usually sell their bone spirit to makers of sal ammoniac, who adopt different modes of proceeding, according to circumstances. Sometimes sal ammoniac is made from bone spirit in the same way as from gas liquor. Some manufacturers digest the bone spirit with ground plaster of Paris (sulphate of lime,) by which carbonate of lime and sulphate of ammonia are formed; the former is precipitated, the latter remains in solution. The liquor being filtered and evaporated yields brown crystals of sulphate of ammonia, which, being mixed with common salt, is submitted to sublimation, by which sulphate of soda and sal ammoniac are obtained.

Properties.—Hydrochlorate of ammonia usually occurs in commerce in the form of large hemispherical cakes, which are translucent, and by exposure to the atmosphere become slightly moist. By solution or sublimation it may be obtained in regular octohedral, or cubic, or plumose crystals: the latter are formed of rows of minute octohedrons, attached by their extremities (Graham.) Its sp. gr. is 1·450. Its taste is saline and acrid; it has no odour. When heated, it sublimes without undergoing fusion or decomposition. It is soluble in about 3 parts of cold and 1 of boiling water: cold being produced during the solution. It dissolves in alcohol.

Characteristics.—It may be recognised by the following characters: it is white and volatile; and if heated on the point of a knife by the flame of a candle, it readily sublimes. Mixed with caustic potash, or quicklime, it evolves ammoniacal gas, which is known by its odour, its action on turmeric paper, and its fuming with the vapour of hydrochloric acid. Dissolved in water the hydrochlorate of ammonia produces, with a solution of nitrate of silver, a white precipitate of chloride of silver, recognised by the properties before described (see p. 226:) and with bichloride of platinum a yellow precipitate *platino-bichloride of ammonia*) which, when collected, dried and ignited, yields spongy platinum.

Composition.—The following is the composition of this salt:—

	Atoms.	*Eq. Wt.*	*Per Ct.*	*Kirwan.*	*Bucholz.*	*Berzel.*
Ammonia	1	17	31·48	25	31	31·95
Hydrochloric Acid	1	37	68·51	75	69	68·05
Hydrochlorate Amm.	1	54	100·00	100	100.	100·00

	Vol.	*Sp. gr.*
Ammoniacal gas	2	0·59027
Hydrochloric Acid gas	2	1·28472

If one equivalent or two volumes of hydrochloric acid gas be mixed with one equivalent or two volumes of ammoniacal gas, combination is effected; the gases disappear, heat is evolved, and the white hydrochlorate is deposited.

1 eq. Ammonia = 17	1 eq. Hydrochl. Acid = 37

Analogy would lead us to regard this salt as a chloride of some metallic base. If such a base exist, it must consist of one equivalent nitrogen and four equivalents hydrogen. Berzelius assumes the existence of this hypothetical metallic base, and calls it *ammonium*, while sal ammoniac is termed by him *chloride of ammonium*. The protoxide of this hypothetical metal will be equal to an equivalent of ammonia and one of water. I have already referred to Dr. Kane's amidogen hypothesis of ammonia; and stated that, according to this view, sal ammoniac is a *chloro-amidide of hydrogen*. The composition of sal ammoniac, according to these hypothetical notions, is as follows:—

	Atoms.	*Eq. Wt.*	*Per Ct.*
Chlorine	1	36	66·6
Ammonium	1	18	53·3
Chloride of Ammonium	1	54	99·9

	Atoms.	*Eq. Wt.*	*Per Ct.*
Chloride of Hydrogen	1	37	31·48
Amidide of Hydrogen	1	17	68·51
Chloro-amidide of Hydrogen	1	54	100·00

Impurities.—The hydrochlorate of ammonia is sometimes rendered impure by the presence of iron, or of lead (see p. 389.)

Physiological Effects. α. *On Vegetables.*—According to Sir H. Davy, (*Agricultural Chemistry.*) water holding in solution 1·300 of its weight of hydrochlorate of ammonia promotes vegetation. Solutions which contained 1·30 of their weight of this salt he found injurious.

β. *On Animals.*—A solution of sal ammoniac mixed with the blood drawn from the body produces no change in the size or shape of the blood-disks. Courten, (*Phil. Trans.* for 1712.) Sprögel, Viborg, and Gaspard (quoted by Wibmer,) (*Die Wirkung*, &c.) injected solutions of sal ammoniac into the veins of animals (dogs and horses:) large doses generally caused convulsions, sometimes paralysis, and death. From the observations of Orfila, Smith, Arnold, (Wibmer, *Op. cit.*) and Moiroud, (*Pharmacol. Vétérinaire.*) this salt appears to be a local irritant, and when introduced into the stomach in large quantities causes vomiting, purging, and gastro-enteritis. It exercises a specific influence over distant organs, for the first three of the above-mentioned experimenters observed that inflammation of the stomach ensued, to whatever part of the body the salt might have been applied, and the convulsions and paralysis before referred to, attest its action on the nervous system. Arnold says it diminishes the plasticity of the blood.

γ. *On Man.*—Wibmer tried this salt on himself. He took from ten to twenty grains for a dose, which he repeated at the end of an hour. The effects were a sensation of warmth and oppression in the stomach, headach, and increased desire of passing the urine.

In this country it is so rarely employed internally that we have very slight experience either of its physiological or of its therapeutical effects. In Germany, where it is more frequently administered, it is in high repute as a powerful alterative or resolvent. (See p. 195.) "Like most salts," says Sundelin, (*Handbuch der speciellen Heilmittellehre*, 1er Bd. S. 150, 3te Aufl.) "sal ammoniac operates on the alimentary canal as an excito-irritant. After its absorption it appears to reduce moderately the action of the heart and large arteries, and, in this respect, belongs to debilitating or temperant agents. But it acts as excitant and irritant to the venous and arterial capillary systems, to the lymphatic vessels and glands, to the skin, to the kidneys, and especially to the mucous membranes; not only increasing secretion but also improving nutrition and assimilation, and counteracting organic abnormal conditions (as tumours, thickenings, and relaxations,) so frequently met with in those structures. It promotes not only the mucous secretions but also cutaneous exhalation, and even menstruation. Its diuretic effects are less obvious. It extends its stimulating influence to the serous and fibrous tissues, whose nutrition it improves.

"From these statements it follows that sal ammoniac operates like the more-profoundly-acting alterative agents, and even approaches, in many respects, mercury, but is especially distinguished from the latter in this, that it by no means acts to such a degree as a liquefacient, nay even melting, agent on solidified organic substance and its crasis, and by its not so powerfully stimulating the lymphatic system. Its long-continued use may, indeed, injure the digestive powers, but never gives rise to general cachexia. I have administered large doses of it against thickening of the mucous membrane, for months, without remarking any injurious effects beyond those just mentioned. In large doses it purges like other salts, but in small ones rather constipates."

Kraus (*Heilmittellehre*, S. 309. Gœttingen, 1831.) says, that a slight miliary eruption and very painful aphthæ have been produced by large doses of it.

Uses.—In this country it is rarely employed internally. In Germany, where it is frequently used, it is administered in the following cases:—

1. *In mild inflammatory fevers*, especially these complicated with affections of the mucous or fibrous membranes, as in the diseases called bilious, gastric, catarrhal or rheumatic fevers, it is employed for promoting secretion and hastening critical discharges.

2. *In inflammation of the mucous or serous membranes*, as catarrh, dysentery, urethritis, peritonitis, pleuritis, &c. when the first violence of the disease has been subdued, but when the secretions and exhalations are not yet established. In these cases it is used as a substitute for mercury.

3. *In chronic diseases* of various kinds, as chronic inflammation of the lungs, liver, and spleen—enlargement of the mesenteric glands—induration of the prostate, uterus, and ovaries—catarrhus vesicæ—chronic ulceration of the uterus—mucous discharges from the urethra and vagina, it is administered as an alterative, as a stimulant to the absorbent system, and as a promoter of healthy secretion.

4. *In amenorrhœa* it is strongly recommended by Sundelin (*Op. cit.*) as an emmenagogue, in those cases in which the disease depends on, or is connected with, inactivity of the uterus.

Externally it is sometimes employed, on account of the cold produced during its solution, in headach, inflammatory affections of the brain, mania, apoplexy, &c. When used for this purpose it must be applied as soon as the salt is dissolved. Mr. Walker (*Phil. Trans.* 1801, p. 120.) found that five parts of this salt, with five parts of nitrate of potash and sixteen parts of water, lowered the thermometer from 50° to 10° F. A mixture of this kind placed in a bladder has been recommended by Sir A. Cooper as an application to hernial tumours, as I have already mentioned (see p. 68.) It may be applied, instead of the ice-cap before noticed (p. 68,) to the head.

As a stimulant and resolvent, or discutient, sal ammoniac is used in the form of *plaster* or *lotion* (see below.) In powder, it is sometimes employed as a dentifrice. A solution of ℥ss. in f℥xij. of water is sometimes used as a gargle.

It is occasionally used to augment the solubility of bichloride of mercury, with which it combines to form a soluble double salt (see *Liquor Hydrargyri Bichloridi.*) Tobacconists use it in the manufacture of snuff.

Administration.—For internal use the dose of it is from five to thirty grains every two or three hours, either in a pulverulent form, combined with sugar or gum, or in solution with some saccharine or mucilaginous solution, to which an aromatic should be added.

Antidote.—In the event of poisoning by this salt, warm water and mucilaginous and demulcent liquids should be given, to promote vomiting. No chemical antidote or counterpoison is known. Gastro-enteritis is, of course, to be combated by the usual means.

1. LOTIO AMMONIAE HYDROCHLORATIS. *Muriate of Ammonia Wash.*—A solution of sal ammoniac, in water or in vinegar, with or without the addition of rectified spirit, is used as a resolvent or discutient lotion or embrocation. The proportions of the ingredients vary according to circumstances. When a strong lotion is required, from one to two ounces of the salt are dissolved in twelve fluid ounces of liquid. Four ounces of rectified spirit are sometimes added. A wash of this strength is used in contusions and ecchymosis, when there is no wound of the skin;—in chronic tumours of the breast;—in white swellings, and other chronic affections of the joints;—in hydrocele, and dropsical enlargement of the thyroid gland;—in chilblains;—in sphacelus, after the requisite scarifications, &c. Weaker solutions (as from ʒj. to ʒiv. of the salt in Oj. of water) are employed as washes in scabies and ulcers; and as injections in gonorrhœa and leucorrhœa.

2. EMPLASTRUM AMMONIÆ HYDROCHLORATIS. *Sal Ammoniac Plaster.* Lead plaster ʒss., Soap ℥ij.; melt them together, and when nearly cold, add Hydrochlorate of Ammonia ℥ss., in fine powder.—This plaster is stimulant and rubefacient. Its efficacy depends on the evolution of ammoniacal gas, in consequence of the action of the alkali of the soap on the hydrochloric acid of the sal ammoniac: hence it requires renewal every twenty-four hours. It is employed as a discutient for chronic swellings and indurations, white swellings, &c. Dr. Paris (*Pharmacologia.*) recommends it in rheumatism of the muscles of the chest, and in pulmonary complaints.

11. LI′QUOR AMMO′NIÆ ACETA′TIS, *L.* (U. S.)—SOLUTION OF ACETATE OF AMMONIA.

(Ammoniæ Acetatis Aqua, *E. D.*)

History.—This solution appears to have been first described in 1732, by Boerhaave, who introduced it into the Materia Medica. It was subsequently employed by Minderer or Mindererus; and hence obtained one of its names, *Spiritus* seu *Liquor Mindereri.*

Natural History.—Acetate of ammonia is, I believe, always an artificial compound.

Preparation.—The *London College* directs this solution to be prepared with Sesquicarbonate of Ammonia ℥ivss., or as much as may be sufficient, and Distilled Vinegar Oiv.; add the Sesquicarbonate of Ammonia to the Vinegar to saturation.

The *Edinburgh College* orders "Distilled Vinegar (from French Vinegar in preference) f℥xxiv.; Carbonate [Sesqui] of Ammonia ℥j.: mix them to dissolve the salt. If the solution has any bitterness, add, by degrees, a little distilled vinegar till that taste be removed. The density of the distilled vinegar should be 1·005, and that of Aqua Acetatis Ammoniæ 1·011."—The *Dublin College* directs one part of [Sesqui] Carbonate of Ammonia to be added gradually, and with frequent agitation, to as much distilled vinegar as may be requisite to saturate the ammonia; namely, about thirty parts. The saturation is to be determined by means of litmus.

[The United States Pharmacopœia directs Diluted Acetic Acid two pints, (see Acetic Acid) Carbonate of Ammonia in powder a sufficient quantity. Add the Carbonate of Ammonia gradually until it is saturated.]

In practice, diluted acetic acid is frequently substituted for distilled vinegar; and as the per centage strength of this acid, as found in commerce, is subject to considerable variation, so must be the strength of the solution of acetate of ammonia. To obviate this, it would have been better if the British Colleges had fixed absolutely the quantity of hydrated sesquicarbonate of ammonia which should be employed to yield a given number of fluid ounces of the solution of acetate of ammonia. Apothecaries then would be at liberty to employ a stronger or a weaker acetic acid, without affecting the strength of the product.[1]

Every equivalent or 118 parts of hydrated sesquicarbonate of ammonia require two equivalents or 102 parts of anhydrous acetic acid to form a neutral compound, while three equivalents or 66 parts of carbonic acid gas are set free. Assuming distilled vinegar to contain 4·6 per cent. of real acid, it follows that 2217·39 parts of distilled vinegar would contain two equivalents or 102 parts of acetic acid.

MATERIALS.		COMPOSITION.		PRODUCTS.	
1 eq. Hydrated Sesquicarbonate of Ammonia....	118	*3 eq. Carbonic Acid..*	66	3 eq. Carbonic Acid....	66
		2 eq. Water.........	18	2 eq. Water............	18
		2 eq. Ammonia......	34		
2 eq. Acetic Acid........	102			2 eq. Acetate Ammonia	136
	220				220

PROPERTIES.—When pure this liquid is colourless. Any tint, therefore, which the solution of the shops may have, is referrible to impurities in either the vinegar or the sesquicarbonate. Filtering it through powdered animal charcoal will usually remove any yellow or brown colour which it may have. If quite neutral, it will affect neither turmeric nor litmus paper. It is better, however, to have a slight excess of acid present than of sesquicarbonate; for if the latter predominate, the solution is much more irritant; and if employed as a collyrium, might produce inconvenient results.

Characteristics.—It is totally dissipated by heat. With nitrate of silver it gives crystals (*acetate of silver*) soluble in water. When concentrated it evolves vapours of acetic acid on the addition of strong sulphuric acid, and gives out ammonia if potash or lime be mixed with it. With sesquichloride of iron it yields a red liquor (*peracetate of iron.*)

COMPOSITION.—By evaporating a saturated solution of acetate of ammonia under the exhausted receiver of the air-pump, and over sulphuric acid, crystals of the acetate are obtained. They are transparent oblique rhomboidal prisms, and consist, according to Dr. Thomson, of

	Atoms.	*Eq. Wt.*	*Per Cent.*
Acetic Acid......................	1	51	38·931
Ammonia..........................	1	17	12·977
Water............................	7	63	48·091
Crystallized Acetate Ammonia..	1	131	99·999

The quantity of dry or anhydrous acetate of ammonia contained in the solution kept in the shops, varies with the strength of the distilled vinegar. Now, according to Mr. Phillips, 100 grs. of distilled vinegar should saturate 13 grains of crystallized carbonate of soda. This would indicate the presence of 4·6 per cent. of acetic acid; and, consequently, 100 grains of liquor ammoniæ acetatis, prepared from such vinegar, would be composed as follows:—

Acetate of Ammonia (dry)..............	6·040	Crystallized Acetate of Ammonia......	11·635
Water.................................	93·959	Water................................	88·364
Liquor Ammoniæ Acetatis (Ph. L.).....	99·999	Liquor Ammoniæ Acetatis (Ph. L.).....	99·999

IMPURITIES.—This solution ought neither to be discoloured by the addition of hydrosulphuric acid, nor to throw down any precipitate by nitrate of silver or chloride of barium. These substances, therefore, may be employed to detect, respectively, metallic matter, hydrochloric acid or a chloride, and sulphuric acid. Pure acetate of ammonia occasions no precipitate with diacetate or acetate of lead;

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[1] For some remarks on the different strengths of this preparation in the different European Pharmacopœias, see Mohr, in the *Berlinisches Jahrbuch für die Pharmacie*, Bd. xliii. S. 253. Berl. 1840.

but the liquor ammoniæ acetatis of the shops usually does, owing to the presence of some free carbonic acid or sesquicarbonate of ammonia.

PHYSIOLOGICAL EFFECTS.—In small doses this solution is regarded as a refrigerant: in large doses, diaphoretic, diuretic, and perhaps resolvent. These effects, however, are not very obvious. Wibmer (*Die Wirkung*, &c.) took it in moderate doses, yet did not observe any diaphoretic, diuretic, or purgative effects from it; but he experienced headach and disturbed digestion. Dr. Cullen (*Materia Medica.*) says, "I have known four ounces of it taken at once, and soon after four ounces more, without any sensible effect." The local operation of this solution is that of a mild stimulant.

USES. α. *Internal.*—It is employed in febrile and inflammatory diseases, and forms a constituent of the ordinary saline draught. It is given in conjunction with nitrate of potash, or tartar emetic, and sometimes with camphor and opium. When administered as a diaphoretic, its operation is to be promoted by the use of tepid diluents and external warmth. Its diuretic effect is assisted by keeping the skin cool, and conjoining the spirit of nitric ether.

β. *External.*—Diluted with water it is sometimes employed as a discutient wash to inflamed and bruised parts. Mixed with six or seven times its volume of rose-water, to which a drachm or two of tincture of opium may sometimes be added, it is employed as a collyrium in chronic ophthalmia.

ADMINISTRATION.—It is given in doses of half a fluid ounce to two or three ounces every five or six hours.

OTHER SALTS OF AMMONIA.

1. **AMMONIÆ SULPHAS;** *Sulphate of Ammonia; Sulphate of Oxide of Ammonium; Oxysulphion of Ammonium; Glauber's Secret Sal Ammoniac.*—This salt is a constituent of soot from coals. It is usually obtained by dissolving hydrated sesquicarbonate of ammonia in diluted sulphuric acid to saturation, and evaporating so that crystals may form as the solution cools. In an impure state it is procured by saturating the ammoniacal liquor of gas works or bone spirit with sulphuric acid; and the sulphate thus obtained is used in the preparation of sal ammoniac. Sulphate of ammonia when crystallized ($NH^3, SO^3, 2\,HO$) contains two equivalents of water; of one of which it may be deprived by heat. Anhydrous sulphate of ammonia does not appear to exist; for when anhydrous sulphuric acid and ammoniacal gas are combined, a compound is formed in which neither sulphuric acid nor ammonia are evident to the usual tests. Its composition is supposed to be $NH^2, SO^2 + HO$, and it has been denominated *sulfamide.*

2. **AMMONIÆ NITRAS;** *Nitrate of Ammonia; Nitrate of Ammonium; Nitrum semivolatile; Nitrum flammans.* This salt is obtained by saturating diluted nitric acid with sesquicarbonate of ammonia, and evaporating so that crystals may form when the solution cools. If the solution be evaporated at a temperature below 100° F., large and beautiful six-sided prisms are obtained, terminated by six-sided pyramids (*prismatic nitrate of ammonia.*) These crystals belong to the right prismatic system, and are isomorphous with nitrate of potash. They consist of one equivalent nitric acid 54, one equivalent ammonia 17, and one equivalent water 9. If the solution be boiled down, fibrous crystals are obtained (*fibrous nitrate of ammonia.*) When dried at 300° F. nitrate of ammonia assumes the form of a compact white mass (*compact nitrate of ammonia.*) In doses not exceeding a scruple, this salt acts as a diuretic; and, according to the experiments of Wibmer (*Die Wirkung der Arzneimittel und Gifte*, Bd. 1, S. 130. München, 1831.) made on himself, it reduces the frequency of the pulse and the animal heat, without affecting the head, chest, or stomach. It has been given in fevers and acute catarrhs, in doses of from one to two scruples. But it is rarely employed.

It is the source from whence *protoxide of nitrogen* is obtained (see p. 283.) As it generates considerable cold while dissolving in water, it is sometimes used to form a freezing mixture. Lastly, it is occasionally employed to promote the incineration of organic substances.

3. **AMMONIAE CITRAS;** *Citrate of Ammonia.*—A solution of this salt is obtained by saturating lemon or lime juice, or a solution of citric acid, with sesquicarbonate of ammonia. 70 grains of the commercial crystals of citric acid, or f℥xvijss. of lemon juice, saturate 59 grains of hydrated sesquicarbonate of ammonia. Liquid citrate of ammonia is employed either in the still or effervescent form as a cooling saline diaphoretic in febrile disorders.