malignant scarlatina, and ulcerated sore throat. It is usually administered, in these cases, in conjunction with the vegetable tonics; as cinchona or quassia. We frequently employ it to counteract phosphatic deposits in the urine. After a copious evacuation, it is, according to Dr. Paris, the most efficacious remedy for preventing the generation of worms; for which purpose the infusion of quassia, stronger than that of the Pharmacopœia, is the best vehicle. It has been employed with benefit in some forms of dyspepsia. Two facts give a remarkable interest to the employment of this acid in dyspeptic complaints; namely, that it is a constituent of the healthy gastric juice; and, secondly, when mixed with mucus, it has a solvent or digestive power in the case of various articles of food, as before mentioned. Lastly, hydrochloric acid has been used in scrofulous and venereal affections, in hepatic disorders, &c.

(*b.*) *External.*—In the concentrated form it is employed as a caustic to destroy warts, and as an application in sloughing phagedæna, though for the latter purpose it is inferior to nitric acid. Properly diluted it forms a serviceable gargle in ulceration of the mouth and throat. The objection to its use as a gargle is its powerful action on the teeth: to obviate this as much as possible, the mouth is to be carefully rinsed each time after using the gargle. It is sometimes applied to ulcers of the throat by means of a sponge. Water acidulated with this acid has been applied to frostbitten parts, to chilblains, &c. An injection composed of from 8 to 12 drops of the acid to three or four ounces of water, has been employed as an injection in gonorrhœa.

ADMINISTRATION.—It is given, properly diluted, in doses of from five to fifteen or twenty minims. The *diluted* acid of the Pharmacopœia may be administered in doses of from half a fluidrachm to one fluidrachm. The most agreeable mode of exhibiting it is in the infusion of roses, using the hydrochloric instead of sulphuric acid.

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

ORDER 6.—NITROGEN, AND ITS COMPOUNDS WITH OXYGEN AND HYDROGEN.

Nitrogé nium.—Ni' trogen.

HISTORY AND SYNONYMES.—This gas was first recognised by Dr. Rutherford, in 1772. He termed it *mephitic air*. Priestley called it *phlogisticated air*. Lavoisier, *a'zote* (*azo'tum*). Cavendish, finding it to be a constituent of nitric acid, gave it the name it now usually bears (nitrogen).

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

(*a.*) *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.

(*b.*) *In the organized kingdom.*—It is a constituent of various vegetable principles, as the organic alkalies, 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. It is very slightly absorbed by water. Its equivalent by weight is 14, by volume 1.

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 (p. 126). 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.

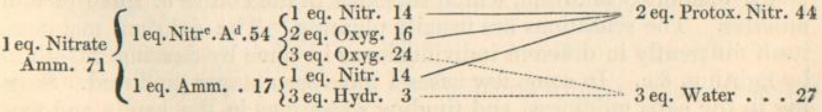
Uses.—It has been mixed with atmospheric air, and inspired in certain pulmonary affections, with the view of diminishing the stimulant influence of the oxygen, and thereby of acting as a sedative. (*Dict. Mat. Med.*)

Nitrogé'nii Protox'ydum.—Protox'ide of Ni'trogen.

History and Synonymes.—This gas was discovered by Dr. Priestley in 1776. He termed it *dephlogisticated nitrous air*. Sir H. Davy, in his "*Researches*" on it, calls it *nitrous oxide*. Its common name is *laughing gas*.

Natural History.—This compound is always an artificial production.

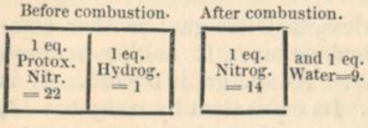
Preparation.—It is obtained by heating nitrate of ammonia in a glass retort. Every equivalent or 71 parts of the salt are resolved into three equivalents or 27 parts of water, and two equivalents or 44 parts of protoxide.



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, 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. 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 of nitrogen and an equivalent or 9 parts of water.



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 a volume.

	Eq.	Eq.Wt.	Per Cent.	Davy.		Vol.	Sp. gr.
Nitrogen	1	14	63·6	63·3	Nitrogen gas	1	0·9722
Oxygen	1	8	36·4	63·7	Oxygen gas	0·5	0·5555
Protoxide Nitrogen	1	22	100·0	10·0	Protox. Nitrogen gas	1	1·5277

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

(*b*.) *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*, p. 77 and 78).

(*c*.) *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.

Ac'idum Ni'tricum.—Ni'tric Ac'id.

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*.

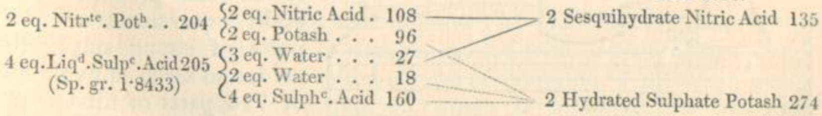
Natural History.—It is found in both kingdoms of nature.

(*a*.) *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).

(*b*.) *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 flowers 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* (Decandolle, *Physiol. Végét.* t. 1$^{\text{er}}$. pp. 383, 387, and 403).

Preparation. (*a*.) *In the Pharmacopœia.*—In the London Pharmacopœia we are directed to mix in a glass retort two pounds of dried nitrate of potash with an equal weight of strong liquid sulphuric acid, and to distil the nitric acid in a sand bath. Mr. Phillips (*Translation of the Pharmacopœia*) says that this process yields nitric acid of sp. gr. 1·5033 to 1·504.

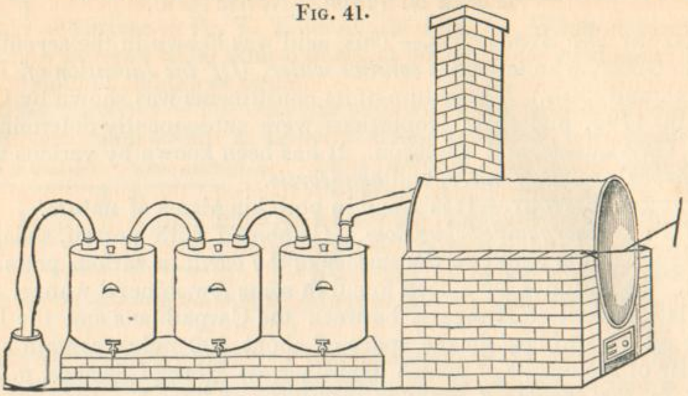
The explanation of the changes which take place is somewhat modified by the strength of the sulphuric acid employed. According to Mr. Phillips, the acid usually met with has a sp. gr. of 1·8433: I have found it generally somewhat below this. The acid alluded to by Mr. Phillips is composed, according 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 re-act 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.



Instead of the glass retort directed in the Pharmacopœia, manufacturers generally employ an iron or stone-ware pot, with a stone-ware head, which is connected with a row of double-necked stone-ware bottles. (See fig. 41, p. 158).

(*b*.) *For commercial purposes.*—The ordinary nitrous and nitric acids of commerce are prepared in an iron cylinder set in brickwork over a

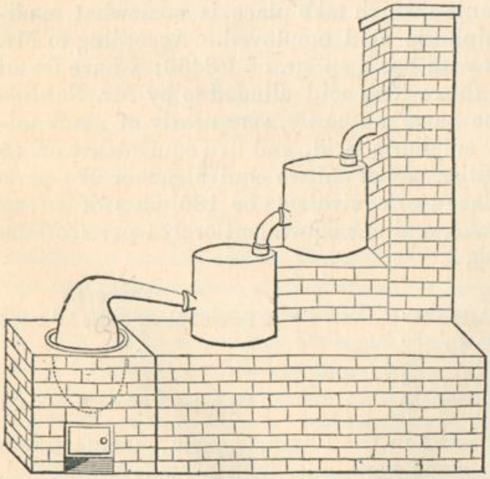
FIG. 41.



Nitric Acid Apparatus.

fire-place (fig. 41). 168lbs. 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 93lbs. 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 stone-ware 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*. To render it colourless it is heated in a glass retort, placed in a sand bath: the vapour which escapes is passed through two stone-ware bottles to save any acid that may be expelled, and is subsequently conveyed into a chimney (fig. 42). The colourless acid remaining in the retort has a sp. gr. of about 1·44, and constitutes the *nitric acid* of commerce. 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 by the alum-makers*.

FIG. 42.



Apparatus for the purification of coloured nitric acid.

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

---

* For the above information I am indebted to Messrs. White, nitric acid manufacturers, Castle Street, Saffron Hill, London, who have kindly permitted me to make the above sketches of their apparatus.

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.

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.

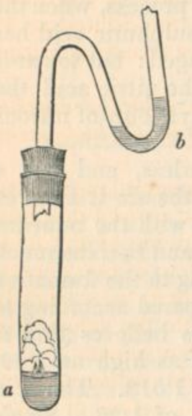
PROPERTIES. — Strong liquid nitric acid is colourless, and has a peculiar odour, and an acrid, intensely sour taste. In the air it evolves white fumes, formed by the union of the acid vapour with the aqueous vapour of the atmosphere; these fumes redden litmus, and become much whiter when mixed with the 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 obtained it as high as 1·62, Kirwan 1·554, Davy 1·55, Gay-Lussac 1·510, Thenard 1·513. The acid sold in the shops as *double aquafortis* has a sp. gr. of 1·36. *Single aquafortis* is of sp. gr. 1·22. It 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 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. 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. 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 analysing atmospheric air: but the results obtained by it are uncertain. Morphia, brucia, or commercial strychnia, communicates a red colour to nitric acid, which is heightened by supersaturating 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 recognized by the protochloride of iron, which strikes a purple or dark 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 recognized 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 recognized by its blackening a solution of protoxide of iron. This last-mentioned property enables us to recognize very minute portions of the nitrates. The mixture of the nitrate, copper filings, and sulphuric acid is to be put into the test-tube (fig. 43 *a.*): adapt, by means of a cork, a small curved glass tube, containing at the bend (*b*) a drop or two of the solution of the protosulphate of iron; apply heat to the mixture in the test-tube, and in a few minutes the ferruginous solution becomes brown or blackish.

FIG. 43.



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

	Eq.	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	100	100	100	100·

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:

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

100 grains of this acid will saturate about 217 grains of carbonate of soda.

The *dilute nitric acid* of the London Pharmacopœia is prepared by mixing a fluid ounce of the strong liquid nitric acid with nine fluid ounces of distilled water. Its sp. gr. is 1·080. 100 grains 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
Dilute Nitric Acid	100·00		100·0

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. To recognise sulphuric acid, add a solution of chloride of barium to the diluted acid; a heavy insoluble white sulphate is thrown down. Any fixed impurities may be obtained by evaporating the acid by heat.

PHYSIOLOGICAL EFFECTS.—(*a.*) *On vegetables.*—Nitric acid decomposes the different vegetable tissues to which it may be applied, and gives them a yellow colour.

(*b.*) *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.

(*c.*) *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 of course 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 alkali or 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 is well shewn in Dr. Roupell's *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 fibrine, 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 head, 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. 81 and 84: 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.—(*a.*) *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 deposits in the urine, 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, 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 antivenereal 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 further 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*).

(*b.*) *External.*—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. Welbank (*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 the 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* (*Unguentum acidi nitrici*, Ph. Dub.) 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 (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 two parts 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. The *dilute nitric acid* may be given to the extent of thirty or forty minims.

The *Unguentum acidi nitrici*, Ph. Dub., also called *pommade d'Alyon*, or *oxygenized fat*, is prepared by adding 5½ fluidrachms of nitric acid to a mixture of one pound of olive oil, and four ounces of prepared hog's-lard. Binoxide of nitrogen is evolved, showing that the nitric acid is decomposed. Part of the fatty matter is oxidized, and a portion is converted into *elaïdine* (see *Unguentum hydrargyri nitratis*). This ointment has a firm consistence and a yellow colour. It is more efficacious when recently prepared.

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

Ac'idum Ni'tro-hydrochlor'icum.—Ni'tro-hydrochlor'ic Ac'id.

HISTORY AND SYNONYMES.—This liquid was known to Geber (*Invention of Verity*, ch. xxiii.). It was formerly called *aqua regia*, or *nitro-muriatic acid.* 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 re-action 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.

INGREDIENTS USED.		RESULTS.
1 eq. Hydrochl^{ic}. 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. Nitr^{s}. Acid 46	1 eq. Nitrous Acid 46

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 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. 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. The *nitro-muriatic bath* 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 be remarkably effective.

ADMINISTRATION.—When taken internally the dose is three or four drops properly diluted and carefully increased.

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

Ammo'nia.—Ammo'nia or *Ammoni'acal Gas.*

HISTORY AND SYNONYMES.—Dr. Black, in 1756, first pointed out the distinction between ammonia and its carbonate; and Dr. Prestley (*On Air*, vol. ii. p. 369, 1790) 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.

(*a*.) *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 recognized in mineral waters (Gairdner, *On Mineral Springs*, p. 15). Ammonia exists in many of the native oxides of iron, and in some chalybeate waters (*Dict. des Drogues*, t. i. p. 293).

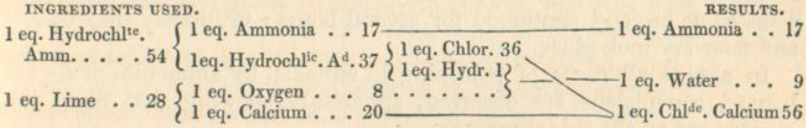
(*b*.) *In the organized kingdom.*—Ammonia is found in vegetables, in small quantities only. In the free state, it is said to exist in several plants, as *Chenopodium vulvaria*, *Sorbus aucuparia* (*Dict. des Drog.*,

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* (Decandolle, *Physiol. Végét.* p. 339). Lastly, it is developed during the decomposition (spontaneous or artificial) of most vegetable substances which contain nitrogen, as gluten.

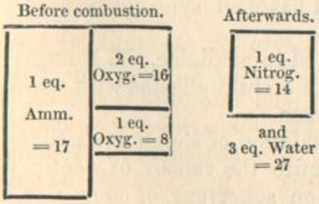
Ammonia is one of the bases found in the urine of man, where it exists in combination with phosphoric, hydrochloric, and uric acids. United to the last-mentioned acid, it exists in the excrement of the boa constrictor, and of some birds. The hydrochlorate is found in the dung of the camel. Ammonia is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



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 sp. gr. of this gas is 0·59. By a pressure of 6·5 atmospheres, at the 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.



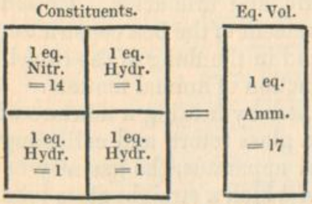
CHARACTERISTICS.—It is readily recognised by its peculiar odour, its action on turmeric paper, and by its forming white fumes with hydrochloric acid or chlorine. Dissolved in water, it communicates a deep blue colour to the salts of copper, and throws down a yellow precipitate (*platino-bichloride of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

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:—

	Eq.	Eq. Wt.	Per Cent.	A. Berthollet.
Nitrogen	1	14	82·35	81·13
Hydrogen	3	3	17·65	18·87
Ammonia	1	17	100·00	100·00

	Vol.	Sp. Gr.
Nitrogen gas	1	0·97222
Hydrogen gas	3	0·20833
Ammoniacal gas	2	0·59027



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

Physiological Effects.—(*a.*) *On vegetables.*—Ammoniacal gas is destructive to plants, and changes their green colour to brown (Decandolle, *Physiol. Vég.*, p. 1344).

(*b.*) *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 shewing that these substances act on the spinal marrow.

(*c.*) *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 its 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 Béziers used it with success in the case of a child affected with croup, 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.

A'qua Ammo'niæ.—Water of Ammo'nia.

History and Synonymes.—The *Liquor ammoniæ* of the London Pharmacopœia is, more properly as I conceive, denominated *aqua ammoniæ* in the United States and Edinburgh Pharmacopœias. In the Dublin Pharmacopœia it is called *aqua ammoniæ causticæ.* It has also been termed *spiritus salis ammoniaci causticus, cum calce viva paratus.*

Preparation.—(*a.*) In the London Pharmacopœia it is prepared from ten ounces of hydrochlorate of ammonia, eight ounces of lime, and two pints of water. The lime, slacked with water, is to be first put into a retort, and then the hydrochlorate of ammonia broken into small pieces: the remainder of the water is then to be added, and fifteen fluid ounces of the solution of ammonia distilled.

The theory of the process is the same as that for making ammoniacal gas just described. The equivalent proportions of hydrochlorate of ammonia and lime are 54 of the first and 28 of the latter. Now it is obvious that more lime is employed in the process of the London Pharmacopœia than is theoretically necessary, if the ingredients were pure. Yet in some other pharmacopœias the quantity is considerably greater. Thus in that of Dublin the proportions are three parts of hydrochlorate, two parts of lime, and ten parts of water. In the Edinburgh and United States Pharmacopœias the quantities are, a pound of hydrochlorate, a pound and a half of lime, a pint (or pound) of distilled water, and nine ounces of distilled water. The distilled water is placed in the receiver to absorb the gas. The advantage contended for by using this great excess of lime is the facility with which the ammonia is disengaged: but this is more than compensated in the Edinburgh and United States processes by the inconvenient bulk of the ingredients. Some excess is of course necessary to allow for impurities.

(*b.*) *In commerce*, the impure sulphate of ammonia is frequently substituted for the hydrochlorate. The apparatus employed is an iron cylinder connected with the ordinary worm refrigerator, and this with a row of double-necked stone-ware bottles containing water, analogous to those described under the head of nitric acid (see *Nitric Acid*).

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. 0·880: it is employed for smelling-bottles. Prepared according to the London Pharmacopœia, the sp. gr. of the water of ammonia is 0·960; according to the Dublin, 0·905; according to the United States, 0·944; and according to the Edinburgh, 0·939. 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 Chem. Phil.* 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, shewing 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. Ph. (sp. gr. 0·960)	Dub. Ph. (sp. gr. 0·950)	U. S. Ph. (sp. gr. 0·944)	Ed. Ph. (sp. gr. 0·939)	Liq. am. fort. (sp.gr.0·880)
Ammoniacal gas	10	12·5	14·5	15·8	30·5
Water	90	87·5	85·5	84·2	69·5
Liquor Ammoniæ	100	100·0	100·0	100·0	100·0

CHARACTERISTICS.—(See *Ammoniacal Gas*).

IMPURITIES.—Liquor ammoniæ frequently contains traces of the 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 of the carbonate of lime. When a portion of the liquid has been neutralized by pure nitric acid, it ought not to cause a precipitate by the addition of the 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.

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

PHYSIOLOGICAL EFFECTS.—(*a.*) *On vegetables.*—The effects of ammonia on plants have been before noticed.

(*b.*) *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 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 (grey matter of the) spinal marrow was specifically affected.

(*c.*) *On man.* α. *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's Treatise*) 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 physician 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 forty-eight 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.

When the solution of ammonia is swallowed in large doses, it acts as a powerfully corrosive poison; but modern well-marked cases 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 be 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.

β. *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. The pulse is soon rendered quicker and fuller; 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. Wibmer (*die Wirkung*, &c. p. 123) has 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, the excitement of the mental functions, and the greater facility with which all the functions are executed, are further indications of the action of ammonia on the nervous system. *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, which terminated fatally in four minutes; though the symptoms are not related.

The *modus operandi* of ammonia deserves to be noticed. Does this substance become absorbed? I am not acquainted with any facts which enable us to decide this question. Even admitting that absorption does take place, it is more likely that the remote effects are of a sympathetic kind, than the result of the absorption. In calculous complaints, ammonia and its carbonate may be used with considerable advantage in those cases where potash and soda are serviceable; from which I think it probable that, like the fixed alkalies, ammonia taken into the stomach is evolved by the kidneys.

USES.—We resort to a solution of ammonia, properly diluted, on a variety of occasions, some only of which can be here noticed.

1. *To neutralize acid.*—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 alkalies may be serviceable, their constant or long-continued use must ultimately be 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, thereby forming the hydrocyanate of ammonia; 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 the explanation is unsatisfactory. 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 remedy 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 employed 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.

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* in a variety of cases with manifest advantage. In recapitulating these, I must be very brief.

(*a.*) In continued fevers which have existed for some time, and where all violent action has subsided, and the brain does not appear much disordered, ammonia 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 does no good, it is less likely to do harm.

(*b.*) In intermittent fevers, ammonia is sometimes of advantage given during the cold stage to hasten its subsidence.

(*c.*) In the exanthemata, when the eruption has receded from the skin, and the extremities are cold, ammonia 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.

(*d.*) 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.

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:* but whenever it gives relief it is by its stimulant operation. 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 this effect was not sufficiently common to lead practitioners to place much reliance on it.

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 it to be sometimes hurtful in viper bites.

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

ANTIDOTES.—The dilute acids, as vinegar, lemon or orange juice, &c.

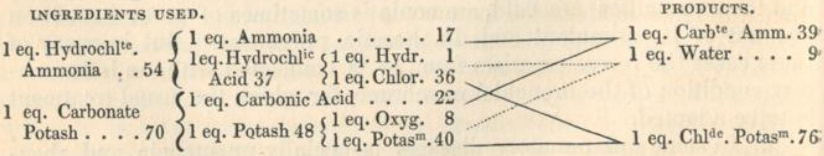
Car'bonas Ammo'niæ.—Car'bonate of Ammo'nia.

HISTORY AND SYNONYMES.—Raymond Lully, in the thirteenth century, was acquainted with carbonate of ammonia as obtained from urine; and it is probable that the Arabians had known it long before. Basil Valentine procured it by decomposing muriate of ammonia by potashes (carbonate of potash).

Carbonate of ammonia has been known by the various appellations of *sal alkali volatile siccum* seu *urinosum; sal volatile salis ammoniaci; subcarbonas ammoniæ; sal volatile cornu cervi,* &c.

NATURAL HISTORY.—(See *Ammonia.*) Carbonate of ammonia is formed during the putrefaction or destructive distillation of those organic substances which contain nitrogen.

PREPARATION, PROPERTIES, EFFECTS, AND USES.—In the pharmacopœia this salt is extracted from hydrochlorate of ammonia by carbonate of potash. The proportions employed in making the *spiritus ammoniæ, spiritus ammoniæ aromaticus,* and *spiritus ammoniæ fœtidus,* are ten ounces of the hydrochlorate and sixteen ounces of the carbonate. One equivalent or 54 parts of the hydrochlorate of ammonia react on one equivalent or 70 parts of carbonate of potash, and produce one equivalent or 39 parts of the carbonate of ammonia, one equivalent or 76 parts of chloride of potassium, and one equivalent or 9 parts of water.



1. *Spiritus Ammoniæ* (Ph. L.)—This compound is prepared from ten ounces of hydrochlorate of ammonia, sixteen ounces of carbonate of potash, three pints of rectified spirit, and three pints of water. This mixture is to be placed in a retort, and three pints distilled. The above-described decomposition takes place, 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. In

the Dublin Pharmacopœia, a similar compound is prepared by mixing three ounces and a half of coarsely-powdered sesquicarbonate of ammonia with three pints of heated rectified spirit; by the disengagement of some carbonic acid, carbonate of ammonia is produced, which dissolves in the spirit, every fluid ounce of which is capable of taking up thirty grains of the carbonate.

The *spiritus ammoniæ* of either of the above pharmacopœias is a transparent, colourless liquid, having a pungent smell and acrid taste. It reddens turmeric paper, and dissolves camphor and the volatile oils. Its medicinal effects and uses are analogous to caustic ammonia and the sesquicarbonate. It is less pungent than the solution of caustic ammonia, but more so than the liquor ammoniæ sesquicarbonatis. It is employed in hysteria, flatulent colic, and nervous debility, in doses of from half a drachm to a drachm, properly diluted with water. Saturated with camphor it forms a highly stimulating liniment.

2. *Spiritus ammoniæ aromaticus* (Ph. L.).—This compound, usually termed *spirit of sal volatile*, is very analogous to the last, from which it differs in the somewhat different proportions of the ingredients, and the addition of some aromatics. It is prepared from five ounces of hydrochlorate of ammonia, eight ounces of carbonate of potash, two drachms of bruised cinnamon, two drachms of bruised cloves, four ounces of lemon-peel, four pints of rectified spirit, and four pints of water. Mix, 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 aromatics. This preparation is weaker than the preceding, but is more agreeable both to the taste and smell. Its effects, uses, and doses, are analogous to those of the last-mentioned compound. It is an ingredient in the *ammoniated tincture of guaiacum* and the *compound tincture of valerian.*

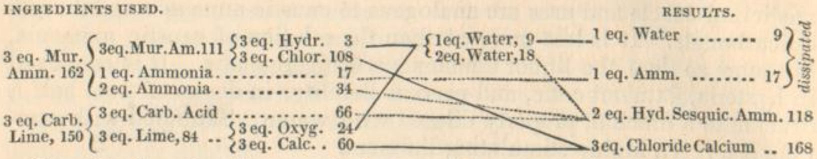
3. *Spiritus ammoniæ fœtidus* (Ph. L.).—This is prepared in the same way as the spiritus ammoniæ, except that five ounces of asafœtida are put into the retort with the other ingredients. It is prepared in the Dublin Pharmacopœia by digesting one ounce and a quarter of asafœtida in two pints of spirit of ammonia, and distilling one pint and a half. This fœtid spirit of ammonia has been very correctly declared to be useless. It is merely a solution of the volatile oil of asafœtida in spirit of ammonia, for which a mixture of the tincture of asafœtida and spirit of ammonia may be conveniently substituted. It is colourless, pungent, and fœtid, and by age becomes brownish. It is employed in hysteria in doses of half a drachm to a drachm in water.

Ammo'niæ Sesquicar'bonas.—Sesquicar'bonate of Ammo'nia.

History and Synonymes.—Though this salt must have been long known, yet, until a few years since, it was confounded with the carbonate of ammonia. It is even now frequently called *carbonate* or *subcarbonate of ammonia* in the shops. It is sometimes termed *volatile* or *smelling salts;* and occasionally *bakers' salt*, on account of its use by bakers in the manufacture of some of the finer kinds of bread.

Natural History.—(See *Ammonia* and *Ammoniæ Carbonas.*)

Preparation.—In the London Pharmacopœia we are ordered to mix a pound of powdered hydrochlorate of ammonia with a pound and a half of powdered chalk, and sublime with a gradually increased heat. In this process three equivalents or 162 parts of hydrochlorate of ammonia react on three equivalents or 150 parts of carbonate of lime, and produce two equivalents 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 subliming pot, the hydrated sesquicarbonate is sublimed, while the ammonia and water are dissipated.



Sesquicarbonate of ammonia is generally procured on the large scale by subliming the ingredients in an iron pot, to which an earthen or leaden head is adapted as a receiver. As a substitute for hydrochlorate of ammonia, manufacturers frequently employ impure sulphate of ammonia; but the resulting sesquicarbonate is sometimes contaminated with a little tar or oil, and deposits a dark carbonaceous matter when dissolved in acids.

PROPERTIES.—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, pulverent, 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, dissolving the carbonate of ammonia, and evolving carbonic acid.

The *liquor ammoniæ sesquicarbonatis* (Ph. L.) is prepared by dissolving four ounces of this salt in a pint of water.

CHARACTERISTICS.—This is recognized as an ammoniacal salt by its odour, its fugacious action on turmeric paper, and by the action of its solution on the salts of copper and on the chloride of platinum (see *Ammonia*). From a solution of caustic ammonia it may be distinguished by the white precipitate which it produces with the calcareous salts. From the monocarbonate this salt is distinguished by the effervescence caused when it is put into boiling water or alcohol. From the bicarbonate it may be known by its greater pungency and solubility.

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

	Eq.	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	2	118	100·00	100·0

IMPURITIES.—This salt is met with in the shops of various degrees of purity. If pure, it should dissolve acids without depositing any blackish matter; it should leave no residuum when heated on platinum or glass;

it should be translucent, and not opaque and pulverent; and, lastly, its solution, saturated with pure nitric acid, should give no precipitate with chloride of barium or nitrate of silver, for the first would indicate sulphuric acid or a sulphate, the second hydrochloric acid or a chloride.

PHYSIOLOGICAL EFFECTS (*a.*) *On vegetables.*—[See *Ammonia.*]

(*b.*) *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 the natural colour, odour, and consistence. Orfila (*Toxicol. Génér.*) 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) 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.

(*c.*) *On man.*—The principal experimenter here is Wibmer (*op. cit.*), who made his trials on himself. He found that a grain and a half of this salt produced no remarkable effect; three grains increased the frequency of the pulse from 68 to 72 beats per minute, with throbbing headache. 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.

From these and other experiments we infer, that the *local* action of this salt is that of an irritant and corrosive; but it is much less powerful than the caustic solution of ammonia, in consequence of the presence of carbonic acid, which in some degree neutralizes the alkaline properties of the ammonia. Swallowed in *moderate doses* (of about 30 grains) it occasions vomiting: in *large doses* it excites pain, inflammation, and all the consequences of an irritant poison; while the immoderate inhalation of its vapour is capable of giving rise to bronchial inflammation. The remote action of this salt is similar to that of caustic ammonia. Thus, in small doses it has the same exciting action on the heart, brain, &c. and the same diaphoretic effect. We denominate it, therefore, stimulant, sudorific, antispasmodic, antacid, and rubefacient.

USES.—Sesquicarbonate of ammonia is used in the same cases and under the same circumstances as the solution of ammonia, to which, therefore, I must refer the reader. In some cases it is also employed in the production of effervescing draughts. The following are the relative proportions of acid and base to be used:—

20 grains of sesquicarbonate of ammonia will saturate about	6	fluidrachms of lemon juice.
	24	grains of crystallized citric acid.
	25½	grains of crystallized tartaric acid.

The *citrate* and *tartrate* of ammonia, obtained as above, are useful in allaying nausea and vomiting; they are also feebly diaphoretic, and in some cases diuretic.

Sesquicarbonate of ammonia has been employed as an emetic in paralysis. An ointment made of the finely pulverized salt and lard is a very useful rubefacient in rheumatic pains, sprains, &c. Mixed with some aromatic oil (as oil of lavender or bergamot) it is employed as a smelling salt against syncope, hysteria, &c.

ADMINISTRATION.—As a stimulant and diaphoretic this salt is used in doses of from five to ten grains, 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.*)

AMMONIACAL SOAPS.—When caustic ammonia is mixed with fatty bodies (such as olive oil, lard, or mutton suet), it forms a kind of soap, composed of the fatty acids, generated by the oil and of ammonia combined with them. Two of these compounds require to be noticed:—

1. *Liniment of ammonia.*—This is prepared, according to the London Pharmacopœia, by mixing a fluid ounce of solution of ammonia with two fluid ounces of olive oil. This compound, sometimes termed *volatile liniment*, is an *oleo-margarate of ammonia;* that is, a compound of oleic and margaric acids with ammonia. It is employed as an external stimulant and rubefacient, to relieve rheumatic and neuralgic pains, sore throat, and various other complaints in which cutaneous stimulants are likely to be useful. It is the

2. *Ointment of ammonia.*—In France an ointment is employed, called *liparolé d'ammoniaque*, or *pommade ammoniacale de Grondret*, and which is composed of eight parts of solution of ammonia, seven parts lard, and one part mutton suet. This compound, rubbed on the skin, and covered by a compress, speedily produces vesication: without the compress it causes rubefaction, merely owing to the volatilization of the ammonia. It is a very useful counter-irritant and vesicant.

Liniment of sesquicarbonate of ammoniæ.—This is prepared by mixing a fluid ounce of the solution of the sesquicarbonate of ammonia with three fluid ounces of olive oil. It forms an imperfect kind of soap, owing to the presence of carbonic acid. Its uses are analogous to those of the liniment of ammonia before mentioned.

Ammo'niæ Bicar'bonas.—Bicar'bonate of Ammo'nia.

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

PREPARATION.—In the Dublin Pharmacopœia it is ordered to be prepared by passing a stream of carbonic acid through a solution of four parts of sesquicarbonate in fifteen parts of water, until the sesquicarbonate be saturated. It is then allowed to remain at rest, and crystals are deposited, which are to be dried without heat, and preserved in a close vessel.

PROPERTIES.—This salt crystallizes in irregular six-sided prisms. It has little or no smell, and less taste than the sesquicarbonate. It is less soluble than the last-mentioned salt, and its solution does not precipitate the magnesian salts, by which circumstance it may be distinguished from the carbonate of ammonia.

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

	Eq.	Eq. wt.	Per cent.	Schrader.	Berthollet.	Phillips.		Vol.
Ammonia	1	17	21·5	19	20	21·16	Ammoniacal gas	2
Carbonic Acid	2	44	55·7	56	55	55·50	Carbonic Acid gas	2
Water	2	18	22·8	25	25	23·34	Aqueous Vapour	2
Crystallized Bicarbon^{te}. Ammonia	1	79	100·0	100	100	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 (Barker and Montgomery's *Observations on the Dublin Pharmacopœia*).

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

Ammo'niæ Hydrochlo'ras.—Hydrochlo'rate of Ammo'nia.

HISTORY AND SYNONYMES.—The early history of this salt is involved in considerable obscurity; for though the term *sal ammoniacus* (ἄλς ἀμμωνίακος), is met with in several old writers, it is believed, by the erudite Beckmann (*Hist. of Inventions*, vol. iv. p. 370), 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, in his *Essay on the Antiquity of Hindoo Medicine* (p. 41), 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 ἄμμος, *sand*, on account of the nature of its soil. Herodotus (lib. iv., cap. 181 et 2) mentions the salt found in this district.

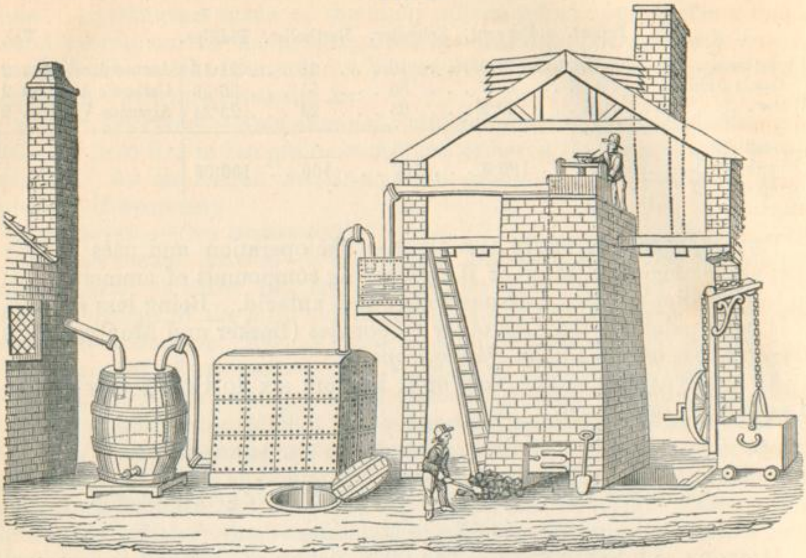
Few substances have had so many synonymes as the hydrochlorate of ammonia; but of those I shall only mention such as are now in use, namely, *muriate of ammonia*, *sal ammoniac*, and *chloride of ammonium*. For others I must refer to Dr. T. Thomson's *Hist. of Chem.* vol. i. p. 125, and *Parr's Med. Dict.*, art. *Ammoniacus*.

NATURAL HISTORY.—(See *Ammonia*).

PREPARATION. (*a*.) *By the destructive distillation of bones.*—Bones are first boiled to remove the fatty matter, which is used in soap making. The larger and finer pieces are then picked out for the manufacture of buttons, handles of tooth-brushes, of knives, &c.; while the smaller and refuse portions are sold as manure. The remaining pieces are distilled.

The still or retort is made of cast iron or of Welch bricks. In a large manufactory (fig. 44) in this metropolis, the retort (which is made of Welch bricks) is placed perpendicularly in the furnace. Its shape

Fig. 44.

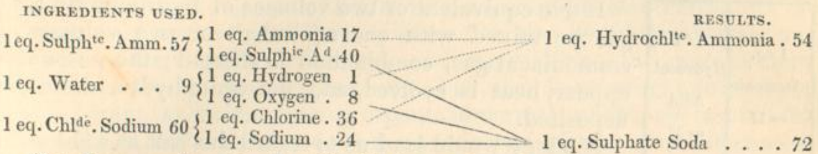


Manufacture of bone spirit (*Carbonate of Ammonia*) *and animal charcoal.*

is a right rectangular prism, the height being twenty feet, the length about three feet, the breadth two feet: it is closed at both top and bottom by a moveable iron plate, and the fire is made around it. The bones are introduced at the upper end of the retort. The volatile products are conveyed (by an iron pipe, which opens into the upper part of the retort) first into water, and then into an iron receiver (in some places an old steam boiler is employed as a receiver) where the brown ammoniacal liquor (*bone spirit*) and the empyreumatic oil (*animal oil*) are deposited. The non-condensable portion is a fœtid inflammable gas: this, after passing through water contained in a second receiver (a cask or vat), 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 powdered and sold as *ivory black*. A coarse powder is employed by sugar refiners for decolorizing saccharine liquids.

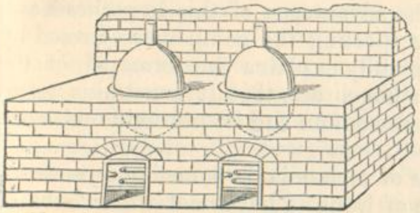
The products of this operation are easily accounted for. When bones are heated, their cartilaginous or gelatinous portion undergoes decomposition, and its elements (carbon, hydrogen, nitrogen, and oxygen) enter into new combinations. Some of the oxygen and hydrogen unite to form water. Carbon and oxygen, 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 oil consists of carbon, hydrogen, and oxygen, with probably some nitrogen.

The carbonate of ammonia contained in the bone spirit is converted into sulphate, either by the addition of sulphuric acid, or by digestion on ground plaster of Paris (sulphate of lime). In the first case carbonic acid is evolved, in the latter we get carbonate of lime formed, from which the solution of sulphate of ammonia is separated by filtering. By evaporation, the solution yields brown crystals of sulphate of ammonia. This is sublimed with common salt, by which we obtain sulphate of soda and hydrochlorate of ammonia. Every equivalent or 57 parts of sulphate of ammonia re-act on one equivalent or 60 parts of chloride of sodium, and with one equivalent or 9 parts of water produce one equivalent or 54 parts of hydrochlorate of ammonia, and one equivalent or 72 parts of sulphate of soda.



(*b*.) *From coals.*—In the distillation of coal as practised at the gas-works, the volatile matters are conveyed to a condensing vessel or refrigeratory, in which are deposited tar and an ammoniacal liquor which contains several salts of ammonia—as the sulphate, carbonate, hydrocyanate, and hydrosulphate. On the addition of sulphuric acid the carbonate, hydrocyanate, and hydrosulphate are decomposed, and by evaporation brown crystals of sulphate of ammonia are obtained. This salt is mixed with chloride of sodium, and heated in an iron pot lined with clay, to which a leaden head having an open cylindrical tube is adapted (fig. 45). The hydrochlorate of ammonia is sublimed into the head of the apparatus. In the clay removed from the pots after the operation, small but perfect and beautiful crystals of the bisulphuret of iron are sometimes found. They are formed during the process. In some cases the gas liquor is saturated with hydrochloric acid, and the brown crystals of hydrochlorate obtained by evaporation are purified by sublimation. The above is a sketch of the process which I saw in operation a few years since at the Westminster Gas Works. At the present time the gas liquor is sold to sal ammoniac manufacturers, who reside in the outskirts of the metropolis.

Fig. 45.



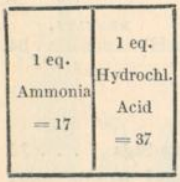
Sublimation of Hydrochlorate of Ammonia.

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 octahedral, or cubic, or plumose crystals. 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 recognized 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, recognized by the properties before described (see p. 105): and with chloride of platinum a yellow precipitate (*the platino-chloride of ammonia*) which when collected, dried, and ignited, yields spongy platinum.

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

	Eq.	Eq.wt.	Per cent.	Kirwan.	Bucholz.	Berzel.		Vol.	Sp. gr.
Ammonia	1	17	31·48	25	31	31·95	Ammoniacal gas	2	0·59027
Hydrochl^{ic}. Acid	1	37	68·51	75	69	68·05	Hydrochl^{ic}. Acid gas	2	1·28472
Hydrochl^{te}.Amm.	1	54	100·00	100	100	100·00			



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.

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 suppositious metal will be equal to an equivalent of ammonia and one of water. The advantages of this hypothesis are, that it obviates certain difficulties respecting the compounds formed by ammonia with the hydracids, and readily explains the formation of the ammoniacal amalgams: its disadvantages are, that it constrains us to admit the existence of two bodies (ammonium and its protoxide) hitherto not known to exist.

Impurities.—The hydrochlorate of ammonia is sometimes rendered impure by the presence of chloride of iron. I have met with cakes of this salt which when broken presented thin, yellow, concentric laminæ of what I believe to be a double salt of chloride of iron and hydrochlorate of ammonia. That the chloride of iron performs, in this yellow compound, the function of an acid, is shown by its not striking a blue colour on the addition of the ferrocyanuret of potassium.

Physiological Effects. (*a.*) *On Vegetables.*—According to Sir H. Davy (*Agricult. 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 to be injurious.

(*b.*) *On Animals.*—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 three first 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.

(*c.*) *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, headache, 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. "Like most salts," says Sundelin (*Handbuch der speciellen Heilmittellehre*, 1er. Bd. p. 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 tumors, 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 defluxing, 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*, p. 309) 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 headache, 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 two parts of this salt, with five parts of nitrate of potash and sixteen parts of water, lowered the thermometer from 50° F. to 10° F. A mixture of this kind placed in a bladder has been recommended by Sir A. Cooper as an application to hernial tumors. It may be applied to the head instead of ice.

Sal ammoniac has been employed externally as a stimulant, or resolvent or discutient. Dr. Paris (*Pharmacologia*) strongly recommends the following stimulant and rubefacient plaster in pulmonary complaints and in rheumatic affections of the muscles of the chest: soap ℥i. lead plaster ʒij., liquified together, to which, when nearly cold, is added of hydrochlorate of ammonia finely powdered, ℥ss. The efficacy of this plaster depends on the evolution of ammoniacal gas in consequence of the action of the alkali of the soap on the hydrochloric acid of the hydrochlorate: hence it should be renewed every twenty-four hours. A strong solution of sal ammoniac (as one or two ounces of the salt to twelve ounces of water) is employed in the cure of contusions and ecchymosis, unaccompanied by any wound of the skin; in chronic tumors, as of the breast; in local dropsies, as hydrocele and dropsy of the thyroid gland; in chilblains; in sphacelus after the requisite scarifications, &c. Weaker solutions (as from one to four drachms of the salt to a pint of water) are employed as washes in scabies and ulcers, as gargles in cynanche, and as injections in gonorrhœa and leucorrhœa. This salt in powder is sometimes used as a tooth-powder.

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

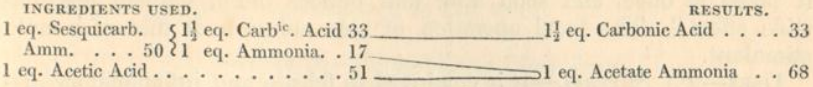
Antidote.—In the event of poisoning by this salt, warm water and mucilaginous and demulcent liquids should be given to promote vomiting. No chemical antidote or counterpoison is known. Gastro-enteritis is of course to be combated by the usual means.

Li'quor Ammo'niæ Aceta'tis.—Solution of Ace'tate of Ammo'nia.

History and Synonymes.—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.—In the London Pharmacopœia this compound is ordered to be prepared by dissolving, in four pints of distilled vinegar, four ounces and a half (or as much as may be sufficient to saturate the acetic acid) of sesquicarbonate of ammonia. Every equivalent, or 51 parts of acetic acid, unite with one equivalent, or 17 parts of ammonia; while one and a half equivalents, or 33 parts of carbonic acid, are evolved.



In the above diagram no notice has been taken of the water in the hydrated sesquicarbonate of ammonia, nor of that in the vinegar.

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. 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.

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

	Eq.	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 grains 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 consist of

Acetate of Ammonia	6·040
Water	93·959
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; 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 temperant and refrigerant: in large doses, diaphoretic and diuretic. 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 headache and disturbed digestion. Dr. Cullen (*Mat. Med.*) 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—(*a.*) *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.

(*b.*) *External.*—Diluted with water it is sometimes applied 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.

ORDER 7.—CARBON, AND ITS COMPOUNDS WITH OXYGEN, HYDROGEN, AND NITROGEN.

Carbo'nium.—Car'bon.

HISTORY.—The term *carbon* (from *carbo, ōnis,* coal) was first employed by Morveau, Lavoisier, and Berthollet, to designate the pure matter of charcoal. To the second of these chemists, we are indebted for demonstrating, that by combustion in oxygen gas the diamond and charcoal yield the same product; namely, carbonic acid gas.

NATURAL HISTORY.—Carbon is found in both kingdoms of nature:

(*a.*) *In the inorganized kingdom.*—When pure and crystallized it constitutes the diamond, which Sir D. Brewster (*Edinb. Phil. Journ.* vol. iii. p. 98, and *Philosoph. Mag.* vol. i. p. 147, 1827) suspects to be of vegetable origin; but a specimen described by Mr. Heuland (*Geol. Trans.*, 2nd series, i. 419), was found in a primary rock. Plumbago and anthracite consist principally of carbon. The bituminous substances (as coal, petroleum, naphtha, &c.) also contain it. These are admitted by geologists to be of vegetable origin. Carburetted hydrogen is evolved from coal strata, marshy places, stagnant waters, &c. Carbonic acid is found either in the free state, as in the atmosphere, in mineral waters evolved from the earth in old volcanic countries, &c., or combined with metallic oxides, in the form of the carbonate of lime, iron, &c. It is remarkable that carbon is rare among the older rocks (De la Beche, *Researches in Theoretical Geology*, p. 32).

(*b.*) *In the organized kingdom.*—Carbon is an essential constituent of all organized beings, vegetable or animal.

PROPERTIES.—Carbon is a solid, odourless, tasteless substance, neither fusible (?) nor volatile; combustible in oxygen gas, yielding carbonic acid gas. Its equivalent by weight is 6. Some years since Dobereiner asserted that he had discovered a metallic basis in it, but his statement has not been confirmed.

The other properties of carbon are so varied, that chemists are obliged