syrup. This solution has also been used as an external agent in lotions. (For other formulæ, see *Bromide of Potassium.*)

Antidotes.—The treatment of cases of poisoning by bromine should be the same as for poisoning by iodine. Barthez has recommended magnesia as an antidote.

COMPOUNDS OF BROMINE WITH OXYGEN, CHLORINE, AND IODINE.

None of these have been employed in medicine; nor have they hitherto been applied to any useful purposes in the arts.

Order V.—HYDROGEN, AND ITS COMPOUNDS WITH OXYGEN, CHLORINE, AND IODINE.

1. HYDROGEN'IUM.—HYDROGEN.

History and Synonymes.—Cavendish may be considered as the real discoverer of hydrogen, though it must have been occasionally procured, and some of its properties known, previously. He termed it *inflammable air.* Lavoisier called it hydrogen (from ὑδωρ, water, and γεννάω, I beget or produce,) because it is the radicle or base of water.

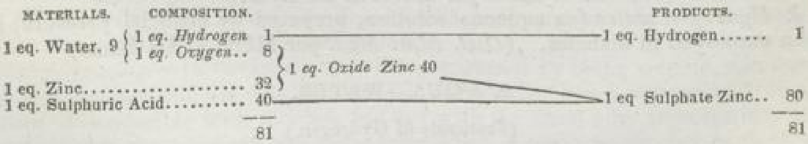
Natural History.—It is found in both kingdoms of nature, but always in combination.

α. In the Inorganized Kingdom.—Next to oxygen, it may be regarded as the most important constituent of the terraqueous globe. It constitutes 11·1 per cent. by weight of water, presently to be noticed. It is an essential constituent of some minerals (as coal and sal ammoniac,) in which it does not exist as an element of water. Lastly, it is evolved from volcanoes, or from fissures in the earth, in combination with carbon, sulphur, chlorine or nitrogen, under the forms of light carburetted hydrogen, sulphuretted hydrogen, hydrochloric acid, and ammonia.

β. In the Organized Kingdom.—Hydrogen is an essential constituent of all organized beings (animals and vegetables,) either combined with oxygen, to form water, or otherwise. Certain fungi exhale hydrogen gas both night and day. (De Candolle, *Phys. Vég.* tom. i. p. 459.)

Preparation.—Hydrogen is always procured by the decomposition of water, but this may be effected in three ways—by the action of electricity, of heat and iron, or of sulphuric acid and a metal (zinc or iron.) The latter method only will require notice here.

Add some granulated zinc to a mixture of 1 part sulphuric acid and 5 or 6 parts of water by measure. One equivalent or 32 parts of zinc decompose one equivalent or 9 parts of water, and unites with one equivalent or 8 parts of oxygen, forming one equivalent or 40 parts of the oxide of zinc, while an equivalent or 1 part of hydrogen is evolved from the water. This equivalent of oxide of zinc combines with an equivalent or 40 parts of sulphuric acid, and forms one equivalent or 80 parts of the sulphate of zinc.



It is remarkable that zinc alone does not decompose water, but sulphuric acid enables it to do so.

Properties.—Hydrogen is a colourless, tasteless, and, when pure, odourless gas. Its sp. gr. is 0·0694,—so that it is 14·4 times lighter than atmospheric air.

Its refractive power is very high. It is combustible, burning in atmospheric air or oxygen gas with a pale flame, and forming water. It is not a supporter of combustion. It is a constituent of some powerful acids, as the hydrochloric, and of a strong base, ammonia. Its atomic weight or equivalent is 1. Its atomic volume is also 1.

1 eq. Hydrogen = 1.

Characteristics.—It is recognised by its combustibility, the pale colour of its flame, its not supporting combustion, and by its yielding when exploded with half its volume of oxygen, water only.

Physiological Effects.—α. *On Vegetables.*—Plants which are deprived of green or foliaceous parts, or which possess them in small quantity only, cannot vegetate in hydrogen gas: thus seeds will not germinate in this gas: but vegetables which are abundantly provided with these parts vegetate for an indefinite time in hydrogen. (Saussure, *Recherches Chém. sur la Végét.* pp. 195 and 209.) Applied to the roots of plants in the form of gas, it is injurious, (Saussure, *Recherches Chém. sur la Végét.* p. 105.) but an aqueous solution of it seems to be inert. (De Candolle, *Physiol. Végét.* t. iii. p. 1360.) It has been said that when plants are made to vegetate in the dark, their etoliation is much diminished if hydrogen gas be mixed with the air around them; and in proof of this Humboldt has mentioned several green plants found in the Freyberg mines. (Thomson's *Syst. of Chemistry*, vol. iv. p. 347–8, 6th edit.)

β. *On Animals generally.*—Injected into the jugular vein of a dog hydrogen produces immediate death, probably from its mechanical effects in obstructing the circulation and respiration. (Nysten, *Recherches*, p. 10.)

γ. *On Man.*—It may be breathed several times without any injurious effects. Scheele made twenty inspirations without inconvenience. Pilatre de Rozier frequently repeated the same experiment, and to show that his lungs contained very little atmospheric air, he applied his mouth to a tube, blew out the gas, and fired it, so that he appeared to breathe flame. If much atmospheric air had been present detonation must have taken place in his lungs. (Beddoes, *New Method of treating Pulmonary Consumption*, p. 44.) If we speak while the chest is filled with hydrogen, a remarkable alteration is perceived in the tone of the voice, which becomes softer, shriller, and even squeaking. That this effect is, in part at least, if not wholly, physical, is shown by the fact that wind instruments (as the flute, pitchpipe, and organ) have their tones altered when played with this gas. The conclusion which has been drawn by several experimenters as to the effects of breathing hydrogen is, that this gas possesses no positively injurious properties, but acts merely by excluding oxygen.

Uses.—α. In *pulmonary consumption* Dr. Beddoes recommended inhalations of a mixture of atmospheric air and hydrogen gas, on the ground that in this disease the system was hyperoxygenized. The inhalation was continued for about fifteen minutes, and repeated several times in the day. (*Op. supra cit.*) Ingenhousz fancied that it had a soothing effect when applied to wounds and ulcers.

β. In *rheumatism and paralysis* it has been used by Reuss as a resolvent.

γ. A *flame of hydrogen* has been employed in Italy as a cautery, to stop caries of the teeth. (*Dict. Mat. Méd.* par Mérat et De Lens.)

δ. *Hydrogen water* (an aqueous solution, prepared by artificial pressure) has been employed in diabetes. (*Dict. Mat. Méd.* par Mérat et De Lens.)

2. A′QUA.—WATER.

(Protoxide of Hydrogen.)

History.—The ancients regarded water as an elementary substance, and as a constituent of most other bodies. This opinion, apparently supported by numerous facts, was held until the middle of the last century, when the Hon. Mr. Cavendish proved that this liquid was a compound of oxygen and hydrogen. It is, however, only doing justice to Mr. Watt, to say, that he had previously inferred this to be the composition of water, but was deterred from publishing his opinion in consequence of some of Dr. Priestley's experiments being, apparently, opposed to it.[1]

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

α. IN THE INORGANIZED KINGDOM.—Water exists in the atmosphere; it forms seas, lakes, and rivers; it is mechanically disseminated among rocks; and, lastly, it constitutes an essential part of some minerals.—In the atmosphere it is found in two states: as a vapour (which makes about one-seventieth by volume, or one one-hundredth by weight, of the atmosphere) it is supposed to be the cause of the blue colour to the sky; and, in a vesicular form, it constitutes the clouds. Terrestrial water forms about three-fourths of the surface of the terraqueous globe. The average depth of the ocean is calculated at between two and three miles. Now, as the height of dry land above the surface of the sea is less than two miles, it is evident, that if the present dry land were distributed over the bottom of the ocean, the surface of the globe would present a mass of waters a mile in depth. Even on the supposition that the mean depth of the sea is not greater than the fourth part of a mile, the solid contents of the ocean would be 32,058,939¾ cubic miles. (Thomson's *System of Chemistry*, 6th ed. vol. iii. p. 195.) The quantity of water disseminated through rocks must be, in the aggregate, very considerable, although it is impossible to form any correct estimate of it. Water enters into the composition of many minerals, either as *water of crystallization*, or combined as a *hydrate*.

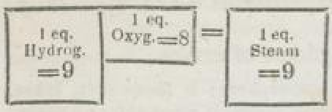
β. IN THE ORGANIZED KINGDOM it is an essential constituent of vegetables and animals.

PROPERTIES.—Pure water has the following properties:—at ordinary temperatures it is a transparent liquid, usually described as being both odourless and colourless; but it is well known that the camel can scent water at a considerable distance; so that to this animal it is odorous;—and as regards its colour, we know that all large masses of water have a bluish-green colour, (For some remarks on the colour of the ocean see Jameson's *Journal*, vol. xxv.) though this is usually ascribed to the presence of foreign matters. When submitted to a compressing force equal to 30,000 lbs. on the square inch, 14 volumes of this liquid are condensed into 13 volumes; so that it is elastic. A cubic inch of water, at 60° F., weighs 255·5 grains; so that this fluid is about 815 times heavier than atmospheric air: but being the standard to which the gravities of solids and liquids are referred, its specific weight is usually said to be 1·. "A pint weighs, at 62°, 8,750 grs., or 20 ozs. avoirdupois; or 1 lb. 6 ozs. 1 drachm 2⅓ scruples, or 10 grs. less than 18¼ ozs. apothecaries' weight." (Mr. Philips's *Translation of the Pharmacopœia*, 4th ed. 1841.) At a temperature of 32° it crystallizes, and in so doing expands. The fundamental form of crystallized water (ice) is the rhombohedron. Water evaporates at all temperatures, but at 212° boils, and is converted into steam, whose bulk is about 1700 times that of water, and whose sp. gr. is 0·6249 (that of hydrogen being 1.) Water unites with both acids and bases, but without destroying their acid or basic properties. Thus the crystallized vegetable acids, tartaric, citric, and oxalic, are atomic combinations of water with what are termed dry acids. Potassa fusa and slacked lime may be instanced as compounds of water and basic substances: these are called *hydrates*. It is a chemical constituent of some crystallized salts; for example, alum, sulphate of soda, and sulphate of magnesia. Here it exists as *water of crystallization*. It rapidly absorbs some gases,—as fluoride of boron, ammonia, &c. It is neither combustible nor a supporter of combustion.

Characteristics.—In the liquid state it is recognised by being volatile, tasteless, odourless, neither acid nor alkaline, and not combustible nor a supporter of combustion: it is miscible with alcohol, but not with the fixed oils: if potassium be thrown on it in the open air, the metal takes fire. Lastly, water may be decomposed into oxygen and hydrogen by the galvanic agency. The most delicate test of aqueous vapour in any gas, is fluoride of boron (commonly called fluoboric acid gas,) which produces white fumes with it.

[1] For farther details respecting the history of the discovery of the composition of water, see Lord Brougham's memoir on the subject, in Jameson's *Edinburgh New Philosophical Journal*, vol. xxvii.

Composition.—The composition of water is determined both by analysis and synthesis. If this liquid be submitted to the influence of a galvanic battery, it is decomposed into two gases; namely, one volume of oxygen, and two volumes of hydrogen. These gases, in the proportions just mentioned, may be made to recombine, and form water, by heat, electricity, or spongy platinum.



	Atoms.	Eq. Wt.	Per Cent.	Berz. & Dulong.
Hydrogen	1	1	11·11	11·1
Oxygen	1	8	88·88	88·9
Water	1	9	100·00	100·0

	Vol.	Sp. Gr.
Hydrogen gas	1	0·0694
Oxygen gas	0·5	0·5555
Aqueous Vapour	1	0·6249

Physiological Effects.—Considered in a dietetical point of view the effects of water on the system have been already considered. (See p. 93.) Moreover, as an agent for the communication or abstraction of heat to or from the body, it has been before noticed. (See *Moist Heat*, a. *Aqueous Vapour*, p. 51; b. *Water*, p. 55; *Cold Water*, p. 60.) Furthermore the influence of atmospheric humidity in modifying the character of climates has likewise been briefly referred to. (See p. 105.)

Water moderately warm, and which neither cools nor heats the body, acts locally as an emollient, softening and relaxing the various tissues to which it is applied. When swallowed it allays thirst, becomes absorbed, mixes with, and thereby attenuates, the blood, and promotes exhalation and secretion, especially of the watery fluids. Administered in large quantities it excites vomiting. The continued excessive use of water has an enfeebling effect on the system, both by the relaxing influence on the alimentary canal and by the excessive secretion which it gives rise to.

Injected into the veins in moderate quantities, tepid water has no injurious effects; it quickens the pulse and respiration, and increases secretion and exhalation. Large quantities check absorption, (See p. 130.) and cause difficulty of breathing and an apoplectic condition. Thrown with force into the carotid artery it kills by its mechanical effect on the brain.

Uses.—Besides the dietetical and thermotic purposes for which water is employed in medicine, and which have been already noticed, it serves as a diluent, humectant, emollient, evacuant, and, in pharmacy, as a solvent.

Water or bland aqueous liquids are employed in some cases of poisoning. They serve to dilute the acrid and irritant poisons, the intensity of whose action on the stomach they lower. Moreover, the presence of aqueous fluids favours the expulsion of substances by vomiting.

In preternatural dryness and rigidity of parts (*e. g.* of mucous surfaces, the skin, wounds, and ulcers,) water and mild aqueous fluids are useful moisteners and emollients.

The copious use of water augments the quantity of fluid thrown out of the system by the cutaneous and pulmonic surfaces, and by the kidneys. If our object be to promote diaphoresis, external warmth should be conjoined with the internal use of diluents; whereas when we wish to excite the renal vessels the skin should be kept cool. In inflammatory affections of the urinary passages, we advise the free employment of aqueous fluids, with the view of diluting the urine, and thereby of rendering it less acrid and irritating.

In Germany there are thirteen or fourteen establishments, formed within the last few years, for the cure of maladies by the use of water. This method of treatment is denominated *Water-cure* (Wassercur,) *Water-medicine* (Wasserheilkunst,) or *Methodus Hydriatica*.

The following is a sketch of the regimen usually adopted at these establishments:—

At four, or half past four in the morning, perspiration is begun to be produced, which is done by wrapping the patients, like babies, in swaddling clothes, or like mummies, in large and thick blankets. Perspiration usually begins in an hour, and is kept up by making the patients drink several glasses of cold water every half hour. In many cases, when the perspiration is at its height, pieces of cloth dipped in cold water, and previously well wrung, are dexterously introduced under the blankets, and applied to the most diseased parts; these parts, as well as the cloths, grow hot, the perspiration soon begins afresh, and causes a sensation of burning in the part.

At the end of three hours the blankets and bed are soaked with perspiration; the patients are then conducted into a neighbouring room, or to another story, where they take their cold baths; and in doing this, they often pass through draughts of air without being inconvenienced. Before plunging into the cold bath, they wash their head and chest; and after staying in it two or three minutes, the patients take a few cups of milk with a little bread, and then walk out upon the mountains which border on the establishment, and drink cold water at the numerous springs which they meet upon their route. About nine or ten o'clock they take the douche, or else walk to the cascades which are in the forests or mountains, and expose themselves to the fall of the water that comes down from a height, and strikes the body with great force. Immediately after dressing, they again drink several glasses of water, and then walk in the open air. (*London Medical Gazette*, for Oct. 12, 1839, p. 111.)

This mode of treatment is recommended for old and young, males and females, and is followed both in summer and winter. It is regarded as a kind of universal remedy or panacea. Thus Oertel (*Die allerneuesten Wasserkuren*, 18 Hefte. Nürnberg, 1829-37.) says it is good for affections of the eyes, ears, and teeth, for insanity, epilepsy, hydrophobia, erysipelas, quinsy, bronchial phthisis, inflammation of the brain, chest, or abdomen, faintings, diseases of the liver and spleen, gout, stomach complaints, acute eruptions, hemorrhages, alvine obstructions, &c. ! ![1]

What is called *Water-dressing* may be regarded as a modified and improved form of poultice. It consists in the application of two or three layers of soft lint dipped in water and applied to inflamed parts, wounds, and ulcers;—the whole being covered with oiled silk or Indian rubber, which should project beyond the margin of the lint, to retain the moisture and prevent evaporation. Dr. Macartney (*Treatise on Inflammation*, p. 180. London, 1838.) considers it to operate differently to a poultice: unlike the latter, he says, it prevents or diminishes the secretion of pus, checks the formation of exuberant granulations, and removes all pain. Moreover, the water is not apt to become sour, like a poultice, and does not injure the sound part.[2]

Water is frequently employed in pharmacy for extracting the active principles of various medicinal agents. The solutions thus procured are termed by the French reformers[3] of pharmaceutical nomenclature, *hydroliques*, or *hydrolica*, (from ὕδωρ, *water*.) Those prepared by solution or mixture are termed *hydrolés*, and are divided by Cottereau (*Traité Elementaire de Pharmacologie.* Paris, 1835.) into three classes; mineral (as lime water,) vegetable (as almond emulsions, mucilage, infusions, decoctions, &c.,) and animal (as broths.) Those obtained by distillation are denominated *hydrolats*.

1. **AQUA DESTILLATA**, L. E., (U. S.) *Aqua Distillata*, D.—*Distilled Water.*—(Obtained by distilling Common Water in a proper still. The first twentieth [fortieth, *L.*, U. S.] part should be rejected: the last portions ought not to be distilled.) The first distilled portion is to be rejected, as it may contain carbonic

---

[1] For farther details concerning this mode of treatment, consult, besides the works above quoted, Fabricius, *Das Ganze der Heilkunst mit kaltem Wasser*, 2te Aufl. Leipzig, 1834;—*Die Wasserkur zu Gräfenberg, oder die Kunst, durch Anwendung des kalten Wassers Wärme zu erzeugen*, Lissa, 1837;—Most, *Encyklopädie der gesammten medicinischen und chirurgischen Praxis*, Band. ii. S. 458, art. *Methodus hydriatica*, Leipzig, 1837.

[2] For farther details respecting the water-dressing, see, besides the work already quoted, *Mém. de l'Académie Royale de Médecine*, Fasc. 1, 1836; *Lancet*, vol. ii. for 1834-5, pp. 121, 277, and 484; and vol. i. for 1835-6, p. 450.

[3] *Pharmaceutical Nomenclature* of MM. Chereau and Henry, in Duncan's *Supplement to the Edinburgh New Dispensatory*, p. 152.

acid, and other volatile impurities. The latter portions are not to be distilled, to guard against empyreuma. The still in which the operation is conducted ought not to be employed for any other purpose, otherwise the water is apt to receive a faint smell, and taste of the last matters subjected to distillation. Distilled water remains unchanged on the addition of any of the following tests:—Solutions of the Caustic Alkalis, Lime, Oxalic Acid, the Barytic Salts, Acetate of Lead, Nitrate of Silver, and Soap. If turbidness, milkiness, or precipitate, be occasioned by any of these, we may infer the existence of some impurity in the water. But water which has been repeatedly distilled gives traces of acid and alkali when examined by the agency of voltaic electricity, which, therefore, is the most delicate test of the purity of water. Nitrate of Silver is the most sensible test of the presence of organic matter: (Dr. Davy, in Jameson's *Edinburgh New Philosophical Journal*, Dec. 1828, p. 129.) a solution of this salt in pure water, preserved in a well-stoppered bottle, undergoes no change of colour by exposure to light; but if any vegetable or animal matter be present, the metal is partially reduced, and the liquid acquires a dark or reddish tint.

2. **AQUAE MEDICATAE**; (U. S.) *Medicated Waters; Aquæ Destillatæ*, L.; *Aquæ Distillatæ*, D.; *Distilled Waters*, E.; *Hydrolata*, or *Hydrolats*.—(Obtained by submitting either fresh, salted, or dried vegetables, or their essential oils, to distillation with water; or by diffusing the essential oils through water by means of spirit, sugar, gum, or magnesia.) The medicated waters prepared by distillation from recent vegetables have a finer flavour than those obtained by the diffusion of the oil; but the latter are purer and more permanent. Rose and Elder Waters are prepared either from the fresh or pickled (salted) flowers. The medicated waters in most common use may be extemporaneously prepared

"by carefully triturating a drachm of any distilled Oil with a drachm of Carbonate of Magnesia, and afterwards with four pints of distilled water. Lastly, let the water be strained.—*Ph. Lond.*

The magnesia effects the minute division of the oil. Moreover, when the oils possess acid properties (as the old oils of pimento, cloves, and cinnamon,) it probably serves to saturate them. Prepared in this way the medicated waters usually contain a minute portion of magnesia in solution: hence, by exposure to the air, they attract carbonic acid, and let fall flocculi of carbonate of magnesia. Moreover, the magnesia unfits them for the preparation of solutions of some of the metallic salts (*e. g.* bichloride of mercury and nitrate of silver.) Sugar is frequently employed, instead of magnesia, to aid the diffusion of the oil through water. Or the oil may be dissolved in rectified spirit, and the solution thus prepared, mixed with water.

3. **INFUSA**, L. D. (U. S.) *Infusions*, E.—These are aqueous solutions of vegetable substances obtained without the aid of ebullition. They are prepared by digesting soft water (cold or hot, according to circumstances) on the substance sliced, bruised, or reduced to coarse powder, in a glazed earthenware or porcelain vessel, fitted with a cover. Polished metallic vessels retain the heat better, but are objectionable on account of their ready corrosion. Hard water is a less perfect solvent of organic matter than soft water, and, moreover, it becomes turbid (from the deposition of chalk) by keeping: hence it should not be employed in the preparation of infusions. Cold water is used when the active principle is very volatile; or when it is desirable to avoid the solution of any substance soluble in hot water. Thus, when the object is to extract the bitter principle from Calumba or Iceland Moss without taking up the starchy matter, cold water is preferred. In general, however, boiling water is used. Infusions are preferred to decoctions when the active principle is either volatilizable by a boiling heat, as in the case of essential oil; or readily undergoes some chemical change by ebullition, as in the case of senna.

4. **DECOCTA**, L. D. (U. S.) *Decoctions*, E.—These are prepared by boiling organic substances in water. They should be strained while hot; since, in some cases (*e. g.* cinchona,) the liquid becomes turbid on cooling.

DIVISION.—Natural waters may most conveniently be arranged in three classes; (See Dr. Thomson's *System of Chemistry*, vol. iii. p. 191, 6th ed. Lond. 1820.) viz. *Common Water*, *Sea Water*, and *Mineral Waters*.

α. Aquae Communes.—Common Waters.

Under this head are comprehended those waters which are used for dressing food, and for other purposes of domestic economy. It includes the waters commonly known as *rain*, *spring*, *river*, *well or pump*, *lake*, and *marsh waters*.

1. **AQUA PLUVIALIS**: *Aqua Pluvia; Aqua Imbrium*; *Rain Water*.—This is the purest of all natural waters. Its composition, however, varies somewhat in different situations, owing to the foreign substances floating in the atmosphere, and with which it becomes contaminated. It contains *air*, *carbonic acid*, some traces of *nitric acid*, *salts*, and *organic matter*. The nitric acid is presumed to be formed by the combination of the oxygen and nitrogen of the air by the agency of electricity.

Liebig[1] has shown that rain water contains carbonate of ammonia, to which he ascribes its softness. Carbonate of lime is another constituent, as is also, according to Bergmann, chloride of calcium. Zimmermann found oxide of iron and chloride of potassium in rain; but Kastner could discover no trace of iron in it, though he found in dew, meteoric iron and nickel. Brandes detected various other inorganic substances, viz. chloride of sodium (in greatest quantity,) chloride of magnesium, sulphate and carbonate of magnesia, and sulphate of lime. He likewise mentions oxide of manganese. The putrefaction to which rain-water is subject, shows that some organic matter is present. The term *pyrrhin* (from πυρρος, red) has been applied by Zimmermann to an atmospheric organic substance which reddens solutions of silver. Whenever rain-water is collected near large towns, it should be boiled and strained before use. As it contains less saline impregnation than other kinds of natural waters, it is more apt to acquire metallic impregnation from leaden cisterns and water pipes. (See p. 94.)

SNOW WATER (*Aqua ex nive; Aqua nivalis*) is destitute of air and other gaseous matters found in rain; and hence fish cannot live in it. It has long been a popular, but erroneous opinion, that it was injurious to the health, and had a tendency to produce bronchocele. But this malady "occurs at Sumatra, where ice and snow are never seen; while, on the contrary, the disease is quite unknown in Chili and Thibet, although the rivers of these countries are chiefly supplied by the melting of the snow with which the mountains are covered." (Paris, *Pharmacologia*, 6th ed. vol. i. p. 79.) Snow does not quench thirst; on the contrary, it augments it; and the natives of the Arctic regions "prefer enduring the utmost extremity of this feeling, rather than attempt to remove it by eating of snow."[2] When melted, however, it proves as efficacious as other kinds of water.

2. **AQUA FONTANA**; *Aqua*, E; *Spring Water*.—This is rain water which, having percolated through the earth, reappears at the surface of some declivity. During its passage it almost always takes up some soluble matters, which of course vary according to the nature of the soil. Its constituents are similar to those of well water.

"For pharmaceutic use, spring water must be so far at least free of saline matter as not to possess the quality of hardness, or contain above a 6000th of solid matter."—*Ph. Ed.*

3. **AQUA EX FLUMINE**; *Aqua Fluvialis; River Water*.—This is a mixture of rain and spring water. When deprived of the matters which it frequently holds in suspension, its purity is usually considerable. The following are the solid con-

---

1 *Organic Chemistry in its Application to Agriculture and Physiology*; edited by Lyon Playfair, Ph. D. Lond. 1840.

2 *Narrative of a Second Voyage in Search of a North-west Passage; and of a Residence in the Arctic Regions during the years* 1829, 1830, 1831, 1832, *and* 1833, p. 366. Lond. 1835.

stituents of the waters of the Thames and Colne, at different localities, according to the analyses of Mr. R. Phillips:—[1]

QUANTITY OF WATER.	THAMES WATER.			COLNE WATER.		
1 Gallon=10 lbs. Avoirdupois, at 62° F. or 70000 grs. Avoirdup.	*Brentford.* Source of the Grand Junction Water Works Company.	*Barnes.* Source of the West Middlesex Water Works Company.	*Chelsea.* Source of the Chelsea Water Works Company	*Otterpool.* Spring near Bushey.	*Main Spring* in the valley that supplies the Colne.	*Colne.* Itself.
	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.
Carbonate of Lime	16·000	16·900	16·500	18·800	19·300	18·100
Sulphate of lime . . . . } Chloride of Sodium . . . }	3·400	1·700	2·900	2·500	2·500	3·200
Oxide of Iron . . . . . } Silica . . . . } Magnesia . . . . . . } Carbonaceous matter . . }	Very minute portions.	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.
Solid matter held in solution .	19·400	18·600	19·400	21·300	21·800	21·300
Mechanical impurity . . .	0·368	0·368	0·238	0·185	0·262	0·126
Total Solid matter . .	19·768	18·968	19·638	21·485	22·062	21·426

No notice is taken in these analyses of the gaseous constituents (air and carbonic acid) of river water.

4. AQUA EX PLUTEO; *Aqua Puteana; Well Water.*—This is water obtained by sinking wells. As it is commonly raised by means of a pump, it is frequently called *pump water.* The constituents of ordinary well water are similar to those of river water above mentioned; but the earthy salts (especially the sulphate of lime) are found in much larger quantity. It usually decomposes and curdles soap, and is then denominated *hard water*, to distinguish it from river and other waters, which are readily miscible with soap, and which are termed *soft waters.* The hardness of water depends on earthy salts, the most common of which is sulphate of lime. By the mutual action of this salt and soap, double decomposition is effected: the sulphuric acid unites with the alkali of the soap, setting free the fatty acids, which unite with the lime to form an insoluble earthy soap. Hard water is a less perfect solvent of organic matter than soft water; hence, in the preparation of infusions and decoctions, and for many economical purposes, as for tea-making and brewing, it is inferior to soft water; and, for the same reason, it is improper as a drink in dyspeptic affections. Moreover, it proves injurious in urinary deposites. The unfavourable effects of hard waters on the animal system are especially manifested in horses. "Hard water, drawn fresh from the well," observes Mr. Youatt, (*The Horse*, p. 359. Lond. 1831.) "will assuredly make the coat of a horse, unaccustomed to it, stare, and it will not unfrequently gripe and otherwise injure him. Instinct, or experience, has made even the horse himself conscious of this; for he will never drink hard water if he has access to soft; he will leave the most transparent and pure [?] water of the well for a river, although the water may be turbid, and even for the muddiest pool."[2]

ARTESIAN WELLS.—These are vertical, cylindrical borings[3] in the earth, through which water rises, by hydrostatic pressure, either to the surface (*spouting* or *overflowing wells,*) or

[1] *Report from the Select Committee of the House of Lords, appointed to inquire into the supply of Water to the Metropolis*, p. 91. 1840.—See also Dr. Bostock's analysis in the *Report of the Commissioners appointed to inquire into the state of the supply of Water in the Metropolis*, 1828.

[2] "Some trainers have so much fear of hard or strange water, that they carry with them to the different courses the water that the animal has been accustomed to drink, and that they know agrees with it."

[3] For description of the mode of boring, and of the tools used, see Ure's *Dictionary of Arts, Manufactures, and Mines*, p. 57. London, 1839.

to a height convenient for the operation of a pump.[1] They have been denominated Artesian, from a notion that they were first made in the district of Artois, in France. It is probable, however, that they were known to the ancients, for a notice of them is said to occur in Olympiodorus.[2] Proposals have been made for supplying London with water by these wells; which would derive their water from the stratum of sand and plastic clay, placed between the London clay and the chalk basin.[3] But it does not appear that a sufficient supply can be obtained in this way.[4]

5. AQUA EX LACU; *Lake Water.*—This is a collection of rain, spring, and river water, usually contaminated with putrefying organic matter, the ill effects of which on the system I have before alluded to. (See p. 94.)

6. AQUA EX PALUDE; *Marsh Water.*—This is analogous to Lake water, except that it is altogether stagnant, and is more loaded with putrescent matter. The sulphates in sea and other waters are decomposed by putrefying vegetable matter, with the evolution of sulphuretted hydrogen; hence the intolerable stench from marshy and swampy grounds liable to occasional inundations from the sea. (See p. 105, foot note.)

TESTS OF THE USUAL IMPURITIES IN COMMON WATERS.—The following are the tests by which the presence of the ordinary constituents or impurities of common waters may be ascertained:—

1. EBULLITION.—By boiling, Air and Carbonic Acid gas are expelled, while Carbonate of Lime (which has been held in solution by the carbonic acid) is deposited. The latter constitutes the fur or crust which lines tea-kettles and boilers.

2. PROTOSULPHATE OF IRON.—If a crystal of this salt be introduced into a phial filled with the water to be examined, and the phial be well corked, a yellowish-brown precipitate (sesquioxide of iron) will be deposited in a few days, if Oxygen gas be contained in the water.

3. LITMUS.—Infusion of litmus or syrup of violets is reddened by a free Acid.

4. LIME WATER.—This is a test for Carbonic Acid, with which it causes a white precipitate (carbonate of lime) if employed before the water is boiled.

5. CHLORIDE OF BARIUM.—A solution of this salt usually yields, with well-water, a white precipitate, insoluble in nitric acid. This indicates the presence of Sulphuric Acid (which, in common water, is combined with lime.)

6. OXALATE OF AMMONIA.—If this salt yield a white precipitate, it indicates the presence of Lime (carbonate and sulphate.)

7. NITRATE OF SILVER.—If this occasion a precipitate insoluble in nitric acid, the presence of Chlorine may be inferred.

8. PHOSPHATE OF SODA.—If the lime contained in common water be removed by ebullition and oxalic acid, and to the strained and transparent water, Ammonia and Phosphate of Soda be added, any Magnesia present will, in the course of a few hours, be precipitated in the form of the white ammoniacal phosphate of magnesia.

9. TINCTURE OF GALLS.—This is used as a test for Iron, with solutions of which it forms an inky liquor (tannate and gallate of iron.) If the test produce this effect on the water before, but not after, boiling, the iron is in the state of Carbonate; if after as well as before, in that of Sulphate. *Ferrocyanide of Potassium* may be substituted for galls as a test for iron, with solutions of the sesquisalts of which it yields a blue precipitate, and with the protosalts a white precipitate, which becomes blue by exposure to the air.

10. HYDROSULPHURIC ACID (*Sulphuretted Hydrogen.*)—This yields a dark (brown or black) precipitate (a metallic sulphuret) with water containing Iron or Lead in solution.

11. EVAPORATION AND IGNITION.—If the water be evaporated to dryness, and ignited in a glass tube, the presence of organic matter may be inferred by the odour and smoke evolved, as well as by the charring. Another mode of detecting organic matter is by adding nitrate of lead to the suspected water, and collecting and igniting the precipitate; when globules of metallic lead are obtained if organic matter be present. The putrefaction of water is another proof of the presence of this matter. Nitrate of silver has been before mentioned as a test. (See p. 242.)

---

[1] In the *Penny Cyclopædia*, art. *Artesian Wells*, is a popular and interesting account of these wells.
[2] Passy, *Description Géologique du Département de la Seine Inférieure*, p. 292. Rouen, 1832.
[3] See an interesting account of Artesian Wells, by Mr. Webster, in the *Athenæum* for 1839, p. 131.
[4] Ibid. Also, *Transactions of the Institution of Civil Engineers*, vol. iii. part iii.

β. Aqua Marina.—Sea Water.

(Aqua Maris.)

Under this head are included the waters of the ocean, and of those lakes, called inland seas, which possess a similar composition. The Dead Sea, however, differs exceedingly in its nature from sea water, and may properly be ranked amongst mineral waters.

The quantity of solid matter varies considerably in different seas, as the following statement from Pfaff[1] proves:—

10,000 *parts of Water of*		*Solid Constituents.*
The Mediterranean Sea		410 grs.
English Channel		380 „
German Ocean	At the Island of Föhr	345 „
	" " Norderney	342 „
	In the Frith of Forth	312 „
	At Ritzebüttel	312 „
Baltic Sea	At Apenrade, in Sleswick	216 „
	At Kiel, in Holstein	200 „
	At Doberan, in Mecklenberg	168 „
	At Travemünde	167 „
	At Zoppot, in Mecklenberg	76 „
	At Carlshamm	66 „

We shall not be far from the truth if we assume that the average quantity of saline water is 3½ per cent.; and the density about 1·0274.

The composition of sea water varies in different localities, as the following analyses[2] show:—

Sea Water.	*Of the English Channel,* (SCHWEITZER.) *Grains.*		*Mediterranean,* (LAURENS.) *Grains.*
Water	964·74372		959·26
Chloride of Sodium	27·05948		27·22
„ „ Potassium	0·76552		0·01
„ „ Magnesium	3·66658		6·14
Bromide of Magnesium	0·02929		—
Sulphate of Magnesia	2·29578		7·02
„ „ Lime	1·40662		0·15
Carbonate of Lime	0·03301	and Magnesia	0·20
	1000·00000		1000·00

Iodine has been found in the Mediterranean by Balard.

PHYSIOLOGICAL USES AND EFFECTS.—Sea water, taken internally, excites thirst, readily nauseates, and, in full doses, occasions vomiting and purging. The repeated use of it, in moderate doses, has been found beneficial, on account of its alterative and resolvent operation in scrofulous affections, especially glandular enlargements and mesenteric diseases. Its topical action is more stimulant than common water. It is used as an embrocation in chronic diseases of the joints. Employed as a bath, it more speedily and certainly causes the reaction and glow; and, consequently, the sea-water bath may be used for a longer period, without causing exhaustion, than the common water bath. It is a popular opinion, which

[1] Schwartze's *Allgemeine und specielle Heilquellenlehre.* 2te Abt. S. 186. Leipzig, 1839.
[2] *Lond. and Edin. Phil. Mag.* vol. xv. p. 51, July 1839. Also, Graham's *Elements of Chemistry*, vol. i. p. 266.

is perhaps well founded, that patients are less likely to take cold after the use of salt water, as a bath, than after the employment of common water.[1]

From sea water is procured Sulphate of Magnesia.

BALNEUM MARIS FACTITIUM; *Artificial Sea-Water Bath.*—A solution of one part of common salt (Chloride of Sodium) in thirty parts of water is a cheap substitute for a sea-water bath. When, however, a more faithful imitation of sea water is desired, the following formula[2] may be used:—Common Salt, 390 grs.; Crystallized Sulphate of Soda, 172 grs.; Crystallized Chloride of Calcium, 36 grs.; Crystallized Chloride of Magnesium, 144 grs.; Water, 1 wine quart. If to these, 1 grain of Iodide of Potassium, and the like quantity of Bromide of Potassium, be added, the imitation will be still more faithful.

γ. Aquae Minerales.—Mineral Waters.

HISTORY.—Mineral waters were known to mankind in the most remote periods of antiquity, and were employed, medicinally, both as external and internal agents, for the prevention, alleviation, and cure of diseases. Homer (*Iliad*, xxii. 147.) speaks of tepid and cold springs. The Asclepiadeæ, or followers of Æsculapius, erected their temples in the neighbourhood of mineral and thermal waters. (Sprengel, *Hist. de Médec.* par Jourdan, t. 1er, p. 144.) Hippocrates (*De aeribus, aquis, locis.*) speaks of mineral waters, though he does not prescribe them when speaking of particular diseases. Pliny (*Hist. Nat.* lib. xxxi.) notices their medical properties.

NATURAL HISTORY.—The principal source of mineral waters is the atmosphere, from which water is obtained in the form of rain, snow, hail, and dew, and which after percolating a certain portion of the earth, and dissolving various substances in its passage, reappears on the surface at the bottom of declivities (*spring water*,) or is procured by sinking pits or wells (*well water*.) But springs are sometimes observed under circumstances which are inconsistent with the supposition of their atmospheric origin. "The boiling springs which emerge on the verge of perpetual snows, at an altitude of 13,000 feet above the level of the sea, as in the Himalayahs, cannot be derived from the atmosphere, not to mention the peculiar relations of the Icelandic Geysers." (Gairdner's *Essay on Mineral and Thermal Springs*, p. 289.) Other sources, therefore, have been sought for, and the writer just quoted enumerates three; viz. the focus of volcanic activity, the great mass of the ocean, or other masses of salt water and subterranean reservoirs.

Fig. 45.

New Geyser.

Considered with reference to their temperature, mineral waters are divided into *cold* and *hot*. The hot or thermal waters are those which possess a temperature more or less elevated above the mean of the latitude or elevation at which they are found, and the changes of which, if any, observe no regular periods coincident with the revolutions of the seasons. Three causes have been assigned as the source of the heat of mineral waters; viz. volcanic action, now in existence; volcanic action, now extinguished, but the effects of which still remain; and, a central cause of heat, which increases as we descend from the surface to the interior of the earth. (Gairdner, *op. cit.*)

The *Geysers*, or boiling springs, of Iceland, are

[1] On the medicinal properties of sea water, consult Logan's *Observations on the Effects of Sea Water in Scurvy and Scrophula*, Lond. 1770; and Dr. R. White, on *The Use and Abuse of Sea Water*, Lond 1775.

[2] This formula agrees with that given by Soubeiran (*Nouveau Traité de Pharmacie*, p. 663, t. 2me, éd. 2nde, Paris, 1840,) and which is founded on Marcet's analysis of sea water.

evidently connected with volcanic action. They are intermittent fountains, which throw up boiling water and spray to a great height into the air.[1]

The origin of the saline and other constituents is another interesting topic of inquiry connected with the natural history of mineral springs. As water in its passage through the different strata of the earth must come in contact with various substances which are soluble in it, we refer certain constituents of mineral waters to solution and lixiviation merely: as chloride of sodium, carbonates of lime and magnesia, iodides and bromides of sodium and magnesium, iron, silica, &c. Chemical action must, in some cases, be the source of other constituents. Thus sulphuretted hydrogen is probably produced by the action of water on some metallic sulphuret (especially iron pyrites:) sulphurous and sulphuric acid, from the oxidation and combustion of sulphur, free or combined. The carbonic acid found in the acidulous or carbonated waters is referrible to the decomposition of carbonate of lime, either by heat or by the action of sulphuric acid. Hydrochloric acid is doubtless produced by the decomposition of some chloride or muriate (probably chloride of sodium or sal ammoniac.) Carbonate of soda must also be considered as the product of some chemical process; thus, that found in the natron lakes of Egypt is supposed to be formed by the action of chloride of sodium on carbonate of lime. (Berthollet, *Essai de Statique Chimique*, 1er part. p. 406.) "The different orifices of the Karlsbad Sprudel discharge annually about 13,000 tons of carbonate of soda, and 20,000 of the sulphate in the crystallized state:" (Gairdner, *op. cit.* p. 325.) but a "very simple calculation is sufficient to show, that the Donnersberg alone, the loftiest of the Bohemian Mittelgebirge, a cone of clinkstone 2,500 feet in elevation, contains soda enough to supply the Karlsbad waters alone for more than 30,000 years." (Ibid. p. 338.)

Division and Properties.—Mineral waters may be classified according to their temperature, their chemical composition, or their medicinal properties. But hitherto no satisfactory classification has been effected by any of these methods, nor perhaps can it be formed. The most convenient arrangement is that founded on chemical composition, and which consists in grouping mineral waters in four classes.

CLASS 1. CHALYBEATE OR FERRUGINOUS WATERS.

(Aquæ furruginoseæ seu martiales.)

These are mineral waters whose predominating or active principle is Iron. Most mineral waters contain this metal, but the term chalybeate is not applied to them unless the quantity of iron be considerable in proportion to the other constituents. These waters have an inky or styptic taste, and become purplish black on the addition of tannic or gallic acid (or substances, as galls and tea, which contain one or both of these acids.) Waters which contain the protosalts of iron yield, on the addition of ferrocyanide of potassium, a white precipitate, which becomes blue by exposure to the air. Those which contain the sesquisalts of iron give a blue precipitate with ferrocyanide of potassium, and become red on the addition of sulphocyanide of potassium.

Chalybeate waters are of two kinds, carbonated and sulphated.

Order 1. Carbonated Chalybeate Waters.—These waters contain the carbonate of the protoxide of iron. By exposure to the air, or by boiling, they attract oxygen, evolve carbonic acid, and deposite the whole of the iron in the form of sesquioxide.

When the carbonate of iron is associated with a large quantity of carbonic acid, which renders the waters brisk, sparkling, and acidulous, they are denominated *highly carbonated* or *acidulo-carbonated chalybeates*, or *acidulo-ferruginous waters*. The Spa and Pyrmont waters are of this kind. When, however, the quantity of carbonic acid is not large, and the waters do not sparkle in the glass, they are termed *simply carbonated chalybeates*, or, from the earthy and alkaline salts which they contain, *saline carbonated chalybeates*. The waters of Tun-

[1] For farther information concerning them, I must refer to Sir G. S. Mackenzie's *Travels in Iceland during the Summer of* 1810, Edinb. 1811; and to Barrow's *Visit to Iceland, by way of Tronyem, &c., in the Summer of* 1834. Lond. 1835.

bridge Wells, Oddy's saline chalybeate at Harrowgate, and the Islington Spa near London, are of this kind.

Order 2. Sulphated Chalybeates.—These contain sulphate of iron. Neither exposure to the air nor boiling precipitates all the iron, and in this respect the sulphated chalybeates are distinguished from the carbonated ones. Some of them contain sulphate of alumina, and are denominated *aluminous sulphated chalybeates*. Of these the Sand Rock Spring, in the Isle of Wight, the Strong Moffat Chalybeate, Vicar's Bridge Chalybeate, and the Passy waters, are examples. The waters of Buckowina, in Silesia, are of this kind; but they contain also chloride of iron. Those sulphated chalybeates which are devoid of sulphate of alumina, may be termed *simply sulphated chalybeates*.

The Chalybeate waters operate in a similar manner to the other ferruginous compounds hereafter to be noticed. They are stimulant, tonic, and astringent. By repeated use they cause blackening of the stools. The acidulated carbonated chalybeates sit more easily on the stomach than other ferruginous agents, in consequence of the excess of carbonic acid which they contain. The aluminous chalybeates are very apt to occasion cardialgia, especially if taken in the undiluted state. The use of this class of waters is indicated in cases of debility, especially when accompanied with that condition of system denominated anæmia. They have long obtained a high celebrity for the relief of complaints peculiar to the female sex. Their employment is contra-indicated in plethoric, inflammatory, and febrile conditions of system.

CLASS 2. SULPHUREOUS OR HEPATIC WATERS.

(Aquæ Sulphureæ seu Hepaticæ.)

These waters are impregnated with hydrosulphuric acid (sulphuretted hydrogen;) in consequence of which they have the odour of rotten eggs, and cause black precipitates (metallic sulphurets) with solutions of the salts of lead, silver, copper, bismuth, &c. Those sulphureous waters which retain, after ebullition, their power of causing these precipitates, contain a sulphuret (hydrosulphuret) in solution, usually of calcium or sodium. All the British sulphureous waters are cold, but some of the continental ones are thermal. The most celebrated sulphureous waters of England are those of Harrowgate;[1] those of Scotland are Moffat and Rothsay; of the continent, Enghein, Barèges, Aix, Aix-la-Chapelle, and Baden.

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF SULPHURETTED HYDROGEN IN SULPHUREOUS WATERS.

	100 *Cubic inches of the Water of*	*Cub. inches of Gas.*	*Authority.*
THERMAL	Barèges in the Pyrenees, contains	20·0	Lüdemann.
	Cauterets in ditto	50·0	Ditto.
	St. Sauveur in ditto	16·6	Ditto.
	Schinznach in C. Aargau in Switz.	30·11	Peschier.
	Aachen in the Lower Rhine	45·78	Monheim.
	Warmbrunn in Silesia	17·17	Osann.
	Landeck in county of Glatz	14·88	Ditto.
	Baden near Vienna	11·83	Ditto.
COLD	Harrowgate in England (old well)	5·94	Scudamore.[2]
	Moffat in Scotland	7·58	Thomson.
	Strathpeffer in ditto (upper well)	9·44	Ditto.
	Enghein in France	1·00	Longchamps.
	Nenndorff in Hesse	40·20	Osann.
	Winslar in Hanover	51·51	Ditto.
	Eilsen in Lippe	27·21	Ditto.
	Meinberg in ditto	30·91	Ditto.
	Weilbach in Nassau	22·32	Ditto.[3]
	Berka in Thuringia	20·60	Ditto.
	Bocklet in Franconia	17·17	Ditto.
	Doberan in Mecklenburg	18·20	Ditto.
	Bentheim in Germany	15·45	Ditto.
	Sironabad in Hesse	2·63	Büchner.
	Dinkhold in Nassau	8·6	Kolb.

[1] See Dr. A. Hunter's *Treatise on the Mineral Waters of Harrowgate.* Lond. 1830.

[2] I have not admitted the waters of Cheltenham into this list, in consequence of the extreme inconstancy of the sulphureous impregnation. Other reasons, however, render it very doubtful if any of the analyses of some of the recent springs represent their *natural* composition.—M. G.

[3] 30·9 Creve (*Stifts Nassau*, p. 577.)—M. G.

The general operation of these waters is stimulant, and is adapted for chronic complaints.[1] They are supposed to possess a specific power over the cutaneous and uterine systems. They are employed both as external and internal agents; in chronic skin diseases (as lepra, psoriasis, scabies, pityriasis, herpes, &c.)—in derangements of the uterine functions (amenorrhœa and chlorosis)—in old syphilitic cases—in chronic rheumatism and gout, and in other diseases in which sulphur or its compounds have been found serviceable, and which will be noticed hereafter. On account of their stimulant effects, they are contra-indicated in all plethoric and inflammatory conditions of the system, and their employment requires caution, especially in weak and irritable constitutions.

CLASS 3. ACIDULOUS OR CARBONATED WATERS.

(Aquæ Acidulæ.)

These waters owe their remarkable qualities to carbonic acid gas, which gives them an acidulous taste, a briskness, a sparkling property; and the power of reddening litmus slightly, but fugaciously, and of precipitating lime and baryta waters. When they have been exposed to the air for a short time, this gas escapes from them, and the waters lose their characteristic properties.

Most mineral and common waters contain a greater or less quantity of free carbonic acid. Ordinary spring or well waters do not usually contain more than three or four cubic inches of carbonic acid gas in 100 cubic inches of water. Dr. Henry found, in one experiment, 3·38 inches. (Thomson's *System Chem.* vol. iii. p. 193, 6th edit.) But the waters called acidulous or carbonated contain a much larger quantity. Those which have from 30 to 60 cubic inches of gas are considered rich; but the richest have from 100 to 200 or more inches. (Gairdner, *op. cit.* p. 30.) Alibert (*Nouveaux Elémens de Thérapeutique*, tom. 3me, p. 517, 5me éd.) states, that the waters of Saint-Nectaire contain 400 cubic inches in 100 of the water.

Most of the waters of this class contain carbonate or bicarbonate of soda: these are termed *acidulo-alkaline*. The Selters[2] (often called Seltzer,) Altwasser, Saltzbrunn, Reinerz, and Pyrmont waters, are of this kind. Frequently they contain carbonate of the protoxide of iron also: they are then termed the *acidulous carbonated chalybeates*, which have been already noticed.

The only acidulous or carbonated spring in Great Britain is that of Ilkeston, near Nottingham, and which has been described by Mr. A. F. A. Greeves, (*Account of the Medicinal Water of Ilkeston*, 1833.) and by Dr. T. Thomson. (*Cyclopædia of Practical Medicine*, art. *Waters, Mineral.*)

---

1 See some *Observations on the Efficacy of Sulphureous Waters in Chronic Complaints*, by Dr. J. Armstrong, in his *Practical Illustrations of the Scarlet Fever*, 2d ed. Lond. 1818.

2 See some *Experiments relative to the Analysis and Virtues of Seltzer Water*, by Dr. Brocklesby, in the *Medical Observations and Inquiries*, vol. iv. p. 7, 2d. ed. Lond. 1772.

DR. M. GAIRDNER'S TABLE OF THE QUANTITY OF CARBONIC ACID IN ACIDULOUS WATERS.

	100 *Cubic inches of Water of*	*Cub. inches of Gas.*	*Temp.*	*Authority.*
THERMAL	Bath in England, contains	4·16	114° F.	Phillips.
	Bristol in do.	12·99	74	Carrick.
	Buxton in do.	0·649	82	Scuddamore.
	St. Nectaire in France	400·0	75	Alibert[1]
	Karlsbad in Bohemia	110·0	165	Berzelius.
	Gurgitello in Ischia	89·14	122	Giudice [2]
	Carratraca in Spain	10·70	66	Alibert.
	Maschuka in the Caucasus	60·9	118	Herrman.
	Eisenberg in do.	32·7	103	Ditto.
	Petersquellen in do.	2·0	195	Ditto.
	Schlengenbad in Nassau (Schachtbrun)	6·0	87	Kastner.
	Ems in do. (Kränchesquelle)	59·9	86	Ditto.
	Ditto (at Wall of Lahn)	42·1	123	Ditto.
	Wiesbaden in do. (No. 1.)	19·7	158	Ditto.
COLD	Tunbridge in England	3·485	..	Scudamore.[3]
	Harrowgate in do. (old sulphur well)	4·125	..	Ditto.
	Cheltenham in do. (old well)	12·50	..	Fothergill, 1788.
	Pitcaithly in Scotland	3·463	..	Murray.
	Andabra in France	100·0	..	Berard.
	Enghien les Bains in do	0·674	..	Longchamps.[4]
	Godelheim in Germany	224·9	..	Witting.
	Cudowa in county of Glatz	202·6	..	Mogalla.
	Pyrmont in Germany	151·1	..	Brandes.
	Königswarth in Bohemia	139·1	..	Wetzler.
	Schwalheim in the Wetterau	129·0	..	Wurzer.
	Bocklet in Franconia	112·5	..	Vogelmann.
	Franzensbad in Bohemia	88·67	..	Trommsdorff.
	Geilnau on the Lahn	163·2	..	Bischof.
	Fachingen on do.	134·8	..	Ditto.
	Selters in Nassau (Nieder)	108·7	..	Ditto.
	Liebenstein in Thuringia	109·9	..	Trommsdorff.
	Tarasp in Switzerland	109·9	..	Capeller.
	Kissengen in Germany	85·85	..	Vogel.
	Imnau in Wurtemburg	89·28	..	Kielmayer.
	Alexandersbad	94·09	..	Hildebrandt.
	Bilin in Bohemia	74·69	..	Reuss.
	Schwalbach in Nassau	73·83	..	Rube.
	Spaa in Germany	74·45	..	Monheim.
	Ballstown, State of New York	300·0	..	Hosack.
	Kislawodsk in the Caucasus	151·2	..	Hermann.
	Dinkhold in Nassau	143·9	..	Kolb.
	Oberlahnstein in do.	55·6	..	Amburger.
	Marienfels in do.	92·5	..	Kastner.
	Soden in do.	88·0	..	Meyer.
	Cronberg in do.	106·2	..	Ditto.
	Montabaur in do.	55·8	..	Jacobi.
	Braubach in do. (Salzborn)	58·4	..	Bruckmann.
	Langenschwalbach (Weinbrunn)	89·1	..	Kastner.
	Marienbad in Bohemia (Kreutzbr.)	125·0	..	Struve.
	Saidschütz in do	20·9	..	Ditto.
	Püllnas in do.	6·9	..	Ditto.[5]

Those acidulous waters which owe their medicinal activity principally to the carbonic acid which they contain, act chiefly on the digestive, renal, and nervous systems; but their effects are transient. They are cooling, refreshing, and exhilarating, and frequently relieve nausea. They augment and alter the renal secretion. Sometimes they occasion a sensation of fulness in the head, or even produce slight temporary intoxication. They are used in some disordered conditions of the digestive organs, especially when connected with hepatic derangement, in dropsical complaints, in uterine affections, and in various other cases, which will be more fully noticed when treating of carbonic acid. When the acidulous waters contain the protocarbonate of iron, their effects and uses are analogous to those of the ferruginous springs already noticed. The acidulo-alkaline waters

---

1 I have assumed the coldest spring to be that which contains this large quantity of gas, which is not particularly specified; there are seven springs, ranging from 74°—104° F.—M. G.

2 Viaggio Medico. Half of the acid escapes at 144°, and the whole at 167°.—M. G.

3 After being heated to 144° F. it contained 2·736.—M. G.

4 Parts by weight in 10,000 of water.—M. G.

5 In all these instances the carbonic acid was obtained by boiling, which expels not only the acid which is in an uncombined state in the natural water, but also the excess, which goes to convert the carbonates of acidulous waters into bicarbonates.—M. G.

are useful in the lithic acid diathesis, in gout and rheumatism, &c. The acidulous or carbonated waters are objectionable, on account of their stimulating effects, in febrile, inflammatory, and plethoric subjects.

CLASS 4. SALINE WATERS.

(Aquæ Salinæ.)

These waters owe their medicinal activity to their saline ingredients; for although they usually contain carbonic acid, and sometimes oxide of iron or hydrosulphuric acid, yet these substances are found in such small quantities as to contribute very slightly only to the medicinal operation of the water.

Saline mineral waters may be conveniently divided into five orders, founded on the nature of the predominating ingredient.

Order 1. Purging Saline waters.—The leading active ingredient of the waters of this order is either the sulphate of soda or the sulphate of magnesia; but the chlorides of calcium and magnesium, which are usually present, contribute to their medicinal efficacy. Those springs, in which the sulphate of magnesia predominates, are called *bitter*—as those of Epsom, Scarborough,[1] Seidlitz, Saidschütz, and Pullna. The springs of Cheltenham,[2] Leamington,[3] and Spital, contain sulphate of soda. In full doses the waters of this order are mild cathartics. In small and repeated doses they act as refrigerants and alteratives. They are useful in diseased liver, dropsical complaints, habitual constipation, hemorrhoids, determination of blood to the head, &c. The Karlsbad, Marienbad, and Franzensbrunn, contain carbonate as well as sulphate of soda.

Order 2. Saline or Brine Waters.—The characteristic ingredient of these waters is chloride of sodium. Iodine or bromine, or both, have been recognised in some of them, and doubtless contribute somewhat to the medicinal effects. The most important brine springs of England are those of Middlewich and Nantwich, in Cheshire; Shirleywich, in Staffordshire; and Droitwich, in Worcestershire. The springs of Ashby-de-la Zouch, in Leicestershire, contain, besides chloride of sodium, a considerable quantity of chloride of calcium. Taken in large quantities, saline or brine waters are emetic and purgative. In small but continued doses they act as alteratives, and are supposed to stimulate the absorbent system. They have been principally celebrated in glandular enlargements, especially those which are of a scrofulous nature. The waters of Wisbaden, Baden-Baden, and Bourbonne, are thermal saline waters. The water of the Dead Sea may be arranged among saline mineral waters.

Order 3. Calcareous waters.—Those saline mineral springs whose predominating constituent is either sulphate or carbonate of lime, or both, are denominated calcareous waters. The Bath, Bristol, and Buxton thermal waters are of this kind. When taken internally, their usual effects are stimulant (both to the circulation and the urinary and cutaneous secretions,) alterative, and constipating; and are referrible, in part, to the temperature of the water, in part to the saline constituents. Employed as baths, they are probably not much superior to common water heated to the proper temperature; but they have been much celebrated in the cure of rheumatism, chronic skin diseases, &c. Bath water[4] is generally employed, both as a bath and as an internal medicine, in various chronic diseases admitting of, or requiring, the use of a gentle but continued stimulus; as chlorosis, hepatic affections, gout, rheumatism, lepra, &c. Buxton water, taken internally, has been found serviceable in disordered conditions of the digestive organs, consequent on high indulgence and intemperance; in calculous complaints, and in gout: employed externally, it has been principally celebrated in rheumatism.[5] The water of Bristol Hot-well is taken in dyspeptic complaints and pulmonary consumption.[6]

---

1 See Dr. Short's *Natural, Experimental, and Medicinal History of the Mineral Waters of Derbyshire, Lincolnshire, and Yorkshire, particularly of Scarborough.* Lond. 1734.

2 See Dr. Scudamore on Cheltenham Waters, in his work on Mineral Waters before quoted.—Also Maccabe's *Treatise on the Cheltenham Waters.* Lond.

3 See Dr. Lambe's Analysis, in the *Manchester Memoirs*, vol. v.—Also Dr. Scudamore's work before quoted; and Dr. Loudon's *Practical Dissertation on the Waters of Leamington Spa.* 1828.

4 For an account of the Bath waters, see Wm. Oliver, *A Practical Dissertation on Bath Waters.* Bath, 1716.
Dr. Sutherland, *Natural History, Analysis, and General Virtues of the Bath and Bristol Waters.* Lond. 1763.
Dr. Falconer, *A Practical Dissertation on the Medicinal Effects of the Bath Waters.* Bath, 1790.
Dr. Gibbes, *A Treatise on the Bath Waters*, 1800.—Another edition, 1812.
Dr. E. Barlow, *Essay on the Bath Waters.* Lond.
Mr. Spry, *A Practical Treatise on the Bath Waters.* Lond. 1822.

5 On the Buxton Waters see an anonymous *Treatise on the Nature and Virtues of Buxton Water*, Lond. 1761; Dr. G. Pearson's *Observations and Experiments for investigating the Chemical History of the Tepid Springs at Buxton*, Lond. 1784; Dr. James Denman's *Observations on the Effects of Buxton Water*, Lond. 1793; Mr. W. H. Robertson's *Medicinal Property of Buxton Water*, Lond. and Sir C. Scudamore's work already quoted.

6 Consult Dr. Carrick's *Dissertation on the Chemical and Medical Properties of the Bristol Hotwell Water.* Bristol, 1797.

Order 4. Alkaline waters.—The mineral waters denominated alkaline, contain carbonate or bicarbonate of soda as their characteristic ingredient. The springs of Teplitz, (*Die Bäder von Teplitz*, von A. Reuss. Teplitz, 1835.) Ems, and Vichy, (See p. 208.) belong to this order. They pass insensibly into, and are, therefore, closely related to, the waters of the preceding classes. Thus, springs which contain carbonate of soda, with a considerable excess of carbonic acid (as those of Carlsbad [See Kreysig's *Internal Use of Waters of Carlsbad.* Lond. 1824.] and Selter,) are denominated *acidulo-alkaline*, and have been already noticed among the *acidulous* or *carbonated waters*. Those in which carbonate of soda is associated with protocarbonate of iron and excess of carbonic acid, have been referred to under the head of *acidulous carbonated chalybeates*. The only waters in this country which contain carbonate of soda, are those of Malvern,[1] in Worcestershire; and Ilkeston in Derbyshire, near Nottingham; but the quantity in both cases is very small. The first, which is a very pure water, contains only 0·61 parts of the carbonate in 10,000 of the water, and the second 3.355 grains in an imperial gallon. For external use, the alkaline waters are principally valuable on account of their detergent qualities. When taken internally, they act on the urinary organs. They may be employed in calculous complaints connected with lithic acid diathesis, in gout, in dyspepsia, &c.

Order 5. Siliceous Waters.—Most mineral waters contain traces of silica, but some contain it in such abundance that they have been denominated siliceous. Thus, in the boiling springs of Geyser and Reikum, in Iceland, it amounts to nearly one-half of all the solid constituents. In these waters the silica is associated with soda (silicate of soda,) sulphate of soda, and chloride of sodium.[2] I am unacquainted with their action on the body. It is probably similar to that of the alkaline waters.

For the following table of the composition of some of the most celebrated mineral waters, I am indebted to Dr. Gairdner's work:[3]—

---

[1] For an account of the Malvern waters, see Dr. J. Wall's *Experiments and Observations on the Malvern Waters.* Worcester, 1763; Dr. M. Wall's *Malvern Waters*, Oxford, 1806; and Mr. Addison's *Dissertation on the Nature and Properties of the Malvern Water.* Lond. 1828.

[2] See Dr. Black's analysis, in the *Trans. of the Royal Soc. of Edin.* vol. iii; also, Faraday's, in Barrow's *Visit to Iceland.*

[3] *Essay on the Natural History, Origin, Composition, and Medicinal Effects of Mineral and Thermal Springs.* Lond. 1832.

FIXED CONSTITUENTS

ENTERING INTO THE COMPOSITION OF SOME OF THE MORE CELEBRATED

MINERAL SPRINGS.

PROPORTIONS IN 10,000 PARTS OF WATER.

NOTE.—In reducing the analyses contained in this Table to a uniform measure, in order to render them susceptible of direct comparison with each other, I have assumed the old English gallon as = 58,338 grains; the wine pint = 7305 grains; the imperial gallon = 70,000 grains; and the German 16-ounce measure = 7368 grains.

The different salts have been reduced to their elementary constituents by Wollaston's scale of chemical equivalents.

Name.	Country.	Acids. Carbonic.	Acids. Sulphuric.	Acids. Muriatic.	Bases. Soda.	Bases. Lime.	Bases. Magnesia.	Oxide of Iron.	Silica.	Sum.	Authority and Date.	Remarks.
THERMAL.												
San Restituta	Ischia	0	19·30	29·65	34·30	2·98	2·35	3·19	0·49	94·44	Giudice	Iron in the state of ferruginous alumina; sub-borate of soda 2·79.
Gurgitello	Ditto	14·53	9·65	11·18	31·45	2·55	9·38	1·39	0·56	74·03	Ditto	Iron as in San Restituta.
Wiesbaden	Nassau	1·38	0·87	25·09	31·99	5·29	0·92	0·05	0·26	57·63	Kastner, 1823	Free carbonic acid 19·9; azote; potash 0·83; alumina 0·56; organic extract 2·37.
Carlsbad Sprudel	Bohemia	7·45	14·50	6·49	24·35	1·73	0·85	0·02	0·75	54·59	Berzelius, 1822	Minute traces of phosphoric and fluoric acids, strontian, alumina, and manganese.
St. Nectaire	France	15·13	0·87	13·08	23·99	2·45	2·14	0·14	1·00	53·94	Berthier	
Vichy	Ditto	15·81	1·55	0·72	24·47	0·27	0	0·01	0	42·75	Ditto	
Ems (Kränchenquelle)	Nassau	20·32	0·76	2·43	14·87	2·65	1·43	0·05	trace	49·74	Kastner, 1830	Alumina, a trace; oxide of manganese 2·42.
Olmitello	Ischia	0	6·81	5·93	5·98	0	1·00	0	0·42	24·43	Giudice	Potash 2·23.
Bath (King's Bath)	England	2·38	8·71	0	2·79	5·29	0·77	0·03	0·37	20·53	Phillips	The magnesia by Scudamore.
Mont d'Or	France	2·80	0·36	2·05	4·74	0·90	0·28	0·19	2·10	13·39	Berthier	
Geyser	Iceland	0	0·81	1·32	2·74	0	0	0	5·40	10·73	Black, 1791	Alumina 0·48.
Chaudes Aigues	France	3·07	0	0·88	3·12	0·01	0·39	0·15	1·16	9·96	Berthier	
Rykum [Reikum]	Iceland	0	0·71	1·55	2·43	0	0	0	3·73	8·47	Black, 1791	Alumina 0·05.
Bristol Hot-well	England	1·02	2·25	1·17	1·17	0·89	0·43	0	0	8·19	Carrick, 1797	Free carbonic acid 12·99.
Schlangenbad	Nassau	3·50	0	0·89	2·42	0·10	0·53	0	0	6·96	Kastner, 1823	Free carbonic acid 6·6.
Teplitz	Bohemia	1·09	0·40	0·29	6·02	0·26	0·18	0·03	0·42	8·24	Berzelius, 1822	Phosphoric acid; potash; alumina.
Buxton	England	0·78	0·06	0·28	0·19	1·04	0·04	0	0	2·70	Scudamore, 1820	Azote 2·61, by Pearson.

Name.	Country.	Carbonic.	Sulphuric.	Muriatic.	Soda.	Lime.	Magnesia.	Oxide of Iron.	Silica.	Sum.	Authority and Date.	Remarks.
COLD.												
Vicar's Bridge	Scotland	0	203·00	0·16	0·16	2·50	13·2	103·00	0	323·10	Connel, 1831	Potash, a trace.
Pullna	Bohemia	4·63	192·83	17·20	75·06	20·36	45·65	0	0·24	341·3	Struve	Potash 3·55.
Saidschutz	Ditto	4·81	97·43	1·43	14·29	6·02	41·92	trace	0·16	177·4	Ditto	Nitric acid 7·73; phosphoric acid; potash 3·61; strontian 0·03; alumina; oxide of manganese.
Leamington (Royal Pump)	England	0	29·60	71·90	37·90	12·00	4·95	1·69	0	159·9	Thomson, 1830	Traces of iod. & brom. by Daubeny.
Harrowgate (old sulphur well)	Ditto	1·20	00·0	76·83	60·50	4·47	1·94	0	0	143·4	Scudamore, 1819	
Airthrey (first spring)	Scotland	0	4·25	76·46	32·10	32·38	0·31	0	0	137·4	Thomson, 1828	
Cheltenham (old well)	England	0	11·05	50·65	45·00	4·20	1·22	trace	0	111·6	Scudamore, 1819	Trace of iodine by Daubeny.
Hartfell aluminous chalyb.	Scotland	0	63·23	0	0	0	0	40·00	0	101·3	Thomson, 1828	Alumina 5·16.
Isle of Wight	England	0	48·58	2·35	6·65	5·68	0·82	14·60	0·96	88·21	Marcet	Alumina 7·77.
Marienbad (Ferdinandsquelle)	Bohemia	9·52	27·00	9·50	38·65	2·87	3·67	0·12	0·20	80·18	Steinmann, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius.
Dunblane (north spring)	Scotland	0·30	2·23	33·55	15·30	14·04	0	0·23	0	63·21	Murray, 1814	
Vals	France	22·48	0·29	3·00	23·34	1·00	0·22	0·06	0·45	61·17	Berthier	
Bilin	Bohemia	29·51	3·81	1·44	22·47	2·47	1·69	0·10	0	57·46	Reuss, 1788	
Franzensbad (Franzensbrunn)	Ditto	5·44	18·50	6·21	26·70	1·26	0	0·37	0·48	53·69	Trommsdorff, 1820	Phosphoric acid, lithion, strontian, alumina, manganese, by Berzelius.
Pitcaithly	Scotland	0·30	0·73	27·20	8·50	12·99	0	trace	0	40·95	Murray, 1814	
Roisdorf	Rhenish Prussia	6·76	2·59	9·70	16·60	1·78	1·33	0·07	0·21	38·11	Bischof, 1826	Potash.
Epsom	England	2·50	14·60	4·21	3·64	11·86	0	0	0	37·04	Daubeny, 1830	Trace of bromine.
Selters (Nieder)	Nassau	5·37	0·18	9·92	16·06	1·37	1·00	0·12	0·38	34·00	Bischof, 1826	Phosphoric acid 0·19.
Fachingen	Ditto	11·49	0·12	2·63	15·63	1·83	1·09	0·07	0·11	33·98	Ditto	Phosphoric acid 0·005.
Soden	Ditto	3·35	0·07	12·30	10·72	4·08	0·06	0·08	1·06	30·89	Meyer, 1820	
Moffat	Scotland	0	2·89	13·09	12·75	0·68	0·20	0	0	30·03	Thomson, 1828	
Pyrmont	Germany	4·40	9·83	0·99	1·29	8·56	1·59	0·26	0·68	27·89	Struve	Phosphoric acid, potash, strontian, Manganese.
Marienfels	Nassau	4·83	0·18	1·88	3·42	2·20	1·27	0·10	trace	15·09	Kastner	Potash 1·19; strontian, manganese, phosphoric acid.
Strathpeffer (pump-room)	Scotland	0	8·32	2·17	6·18	2·33	0·30	0	0	15·30	Thomson, 1828	Potash ?
Geilnau	Nassau	6·00	0·07	0·18	5·03	1·60	1·40	0·13	0·14	14·65	Bischof, 1826	Phosphoric acid 0·19.
Weilbach	Ditto	3·61	0·81	1·31	4·60	1·53	2·05	0	0	14·40	Creve, 1810	Sulphur resin 0·48.
Hartfell Spa	Scotland	0	2·70	2·05	0	2·20	0	2·49	0	9·95	Thomson, 1828	Alumina, a trace.
Langenschwalbach (Weinbrunn)	Nassau	3·84	0·12	0·12	0·34	1·55	1·65	0·07	trace	8·58	Kastner, 1829	Potash, lithion, iodine, strontian, alumina, manganese, phosphr. acid.
Spa	Germany	6·63	0·51	0·33	0·93	0·74	0·72	7·90	0·68	5·92	Struve	Phos. acid; potash 0·58; manganese.
Carlsbad (Sauerling)	Bohemia	0·28	0·13	0·07	0·28	0·16	0·06	0·06	0·61	1·42	Berzelius, 1822	Phosphoric acid, fluate of lime, alumina, oxide of manganese.
Tonbridge	England	0·00	0·14	0·29	0·19	0·38	0·03	0·38	0·07	1·32	Scudamore, 1816	Oxide of manganese.
Malvern	Ditto	0·32	0·14	0·09	0·53	0·03	0·02	0·04	0	1·01	Philip, 1805	

For farther details, respecting mineral waters in general, the reader is referred to the following works:—

Dr. J. Rutty, *Methodical Synopsis of Mineral Waters.* Lond. 1757.
Dr. D. Munro, *Treatise on Mineral Waters.* Lond. 1770.
Dr. W. Saunders, *Treatise on the Chemical History and Medical Powers of some of the most celebrated Mineral Waters.* Lond. 1800.
C. F. Mosch, *Die Bäder und Heilbrunen Deutschlands und der Schweiz.* Leipzig, 1819.
Alibert, *Précis historique sur les Eaux Minérales.* Paris, 1826. Also, in his *Nouveaux Elémens de Thérapeutique*, 3me tom. 5me éd. Paris, 1826.
E. Osann, *Physikalish-medicinische Darstellung der bekannten Heilquellen der vorzüglichsten Länder Europa's.* Berlin, 1er Theil, 1829. 2er Theil, 1822.
Dr. T. Thomson, *Cyclopædia of Practical Medicine*, art. *Waters, Mineral*, vol. iv. Lond. 1835.
Mr. Lee, *An Account of the most frequented Watering Places on the Continent.* Lond. 1836.
Patissier et Bourtron-Charlard, *Manuel des Eaux Minérales Naturelles*, 2nde ed. Paris, 1837.
Dr. A. B. Granville, *The Spas of Germany*, Lond. 1837. 2nd éd. 1838.
G. W. Schwartze, *Allgemeine und specielle Heilquellenlehre.* Leipzig, 1839.
Mr. Lee, *Principal Baths of Germany*, 1840.
Dr. J. Johnson, *Pilgrimage to the Spas.* Lond. 1841.
Dr. A. B. Granville, *The Spas of England*, Northern, Midland, and Southern. 1841.

ARTIFICIAL MINERAL WATERS.—In this country the demand for artificial mineral waters is exceedingly limited, and I do not, therefore, think it necessary to enter into any details respecting their manufacture; but shall content myself with referring those interested in the matter to the works of Soubeiran[1] and Guibourt[2] for full details.[3]

3. AC'IDUM HYDROCHLO'RICUM.—HYDROCHLORIC ACID.

(Acidum Muriaticum, Muriatic Acid, U. S.)

HISTORY AND SYNONYMES.—Liquid hydrochloric acid was probably known to Geber, the Arabian chemist, in the eighth century. The present mode of obtaining it was contrived by Glauber. Some modern chemists term it *chlorhydric acid.* Scheele, in 1774, may be regarded as the first person who entertained a correct notion of its composition. To Sir H. Davy we are principally indebted for the establishment of Scheele's opinion.

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

α. IN THE INORGANIZED KINGDOM.—Hydrochloric acid is one of the gaseous products of volcanoes. Combined with ammonia, we find it in volcanic regions.

β. IN THE ORGANIZED KINGDOM.—Free hydrochloric acid is an essential constituent of the gastric juice in the human subject. Hydrochlorate of ammonia (sal ammoniac) was found, by Berzelius, in the urine. Chevreul states he detected free hydrochloric acid in the juice of *Isatis tinctoria.*

1. Gaseous Hydrochloric Acid.

PREPARATION.—Hydrochloric acid, in the gaseous state, is procured by the action of oil of vitriol on dried chloride of sodium. The ingredients should be introduced into a tubulated retort, the neck of which is lined with bibulous paper, and the gas collected over mercury. Or they may be placed in a clean and dry oil flask, and the gas conveyed, by means of a glass tube curved twice at right angles, into a proper receptacle, as a bottle, from which the gas expels the air by its greater gravity.

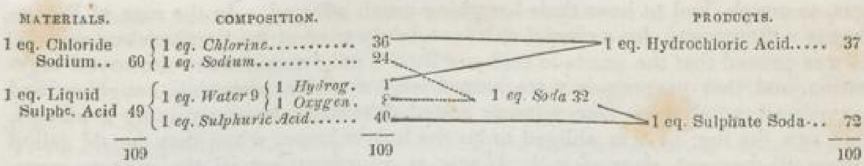
In this process, one equivalent or 60 parts of chloride of sodium react on one equivalent or 49 parts of the protohydrate of sulphuric acid (strong oil of vitriol,) and produce one equivalent or 37 parts of hydrochloric acid (gas,) and one equivalent or 72 parts of the sulphate of soda.

---

[1] *Nouveau Traité de Pharmacie*, t. ii. 2nde édit. Paris, 1840.

[2] *Pharmacopée Raisonnée, ou Traité de Pharmacie pratique et theorique*, par N. E. Henry et G. Guibourt. 3me édit, revue et considérablement augmentée par N. J. B. G. Guibourt. Paris, 1841.—The *Codex Pharmacopée Francaise* also contains formulæ for the preparation of artificial mineral waters.

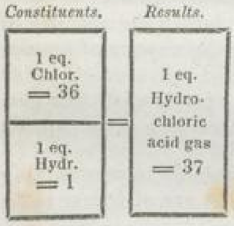
[3] The manufacture of *Sodaic* and *Magnesian Waters* will be described hereafter.



PROPERTIES.—It is a colourless invisible gas, fuming in the air, in consequence of its affinity for aqueous vapour. It is rapidly absorbed by water. Its specific gravity is, according to Dr. Thomson, 1·2847 [1·269 Berzelius.] It has a pungent odour and acid taste. Under strong pressure (40 atmospheres) it becomes liquid. It is neither combustible nor a supporter of combustion. When added to a base (that is, a metallic oxide,) water and a chloride are the results. The atomic weight of hydrochloric acid is 37 [36·47 Berzelius; 36·42 Turner.]

Characteristics.—Hydrochloric acid gas is known by its fuming in the air, by its odour, by its reddening moistened litmus paper, by its forming white fumes with the vapour of ammonia, and by its action on a solution of nitrate of silver, as will be mentioned when describing the liquid acid.

COMPOSITION.—The composition of this gas is determined both by analysis and synthesis. Thus, one volume of chlorine gas may be made to combine with one volume of hydrogen gas, by the aid of light, heat, or electricity, and the resulting compound is two volumes of hydrochloric acid gas. Potassium or zinc heated in this acid gas, absorbs the chlorine and leaves a volume of hydrogen.



	Atoms.	*Eq Wt.*	*Per Ct.*		*Vol.*	*Sp. gr.*
Chlorine.......	1	36 ..	97·297	Chlorine gas...........	1	2·5
Hydrogen.......	1	1 ..	2·702	Hydrogen gas.........	1	0·0694
Hydrochlc. Acid....	1	37 ..	100·000	Hydrochloric Acid gas.............	2	1·2847

PHYSIOLOGICAL EFFECTS. α. *On Vegetables.*—Mixed with 20,000 times its volume of atmospheric air, this gas is said, by Drs. Christison and Turner, (Christison's *Treatise on Poisons.*) to have proved fatal to plants, shrivelling and killing all the leaves in twenty-four hours. But according to Messrs. Rogerson, (*London Medical Gazette*, vol. x. p. 312.) it is not injurious to vegetables when mixed with 1500 times its volume of air. Dr. Christison ascribes these different results to Messrs. Rogerson having employed jars of too small size. We have good evidence of the poisonous operation of this gas on vegetables in the neighbourhood of those chemical manufactories in which carbonate of soda is procured from common salt. The fumes of the acid which issue from these works have proved so destructive to the surrounding vegetation, that in some instances the proprietors have subjected themselves to actions at law, and have been compelled either to pay damages, or to purchase the land in their immediate vicinty.

β. *On Animals* this gas acts injuriously, even when mixed with 1500 times its volume of atmospheric air. Mice or birds introduced into the pure gas, struggle, gasp, and die within two or three minutes. Diluted with atmospheric air, the effects are of course milder, and in a ratio to the quantity of air present. In horses it excites cough and difficulty of breathing. When animals are confined in the dilute gas, in addition to the laborious and quickened respiration, convulsions occur before death. Messrs. Rogerson state, that "in a legal suit for a general nuisance, tried at the Kirkdale Sessions-house, Liverpool, it was proved that horses, cattle, and men, in passing an alkali-works, were made, by inhaling this gas, to cough, and to have their breathing much affected. In the case of Whitehouse *v.* Stevenson, for a special nuisance, lately tried at the Staffordshire assizes, it was proved that the muriatic acid gas from a soap manufactory destroyed vegetation, and that passengers were seized with a violent sneezing, coughing, and occasional vomiting. One witness stated, that when he was driving a plough, and saw the fog, he was obliged to let the horses loose, when they would gallop away till they got clear of it." It acts as an irritant on all the mucous membranes.

γ. *On Man* this gas acts as an irritant poison, causing difficult respiration, cough, and sense of suffocation. In Mr. Rogerson's case it caused also swelling and inflammation of the throat. Both in man and animals it has appeared to produce sleep.

The action of hydrochloric acid gas on the lungs is injurious in at least two ways: by excluding atmospheric air, it prevents the decarbonization of the blood: and, secondly, by its irritant, and perhaps also by its chemical properties, it alters the physical condition of the bronchial membrane. The first effect of attempting to inspire the pure gas seems to be a spasmodic closure of the glottis. Applied to the conjunctiva, it causes irritation and opacity.

Use.—It has been employed as a *disinfectant*, but is admitted on all hands to be much inferior to chlorine. The Messrs. Rogerson deny that it possesses any disinfecting property. It is perhaps equally difficult either to prove or disprove its powers in this respect. The experiments of Guyton-Morveau, in purifying the cathedral of Dijon, in 1773, are usually referred to in proof of its disinfecting property. If it possess powers of this kind, they are certainly inferior to chlorine, or to the chlorides [hypochlorites] of lime or soda; but in the absence of these, hydrochloric acid gas may be tried. In neutralizing the vapour of ammonia it is certainly powerful.

Application.—In order to fumigate a room, building, or vessel, with this gas, pour some strong oil of vitriol over dried common salt, placed in a glass capsule or iron or earthen pot, heated by a charcoal fire or hot sand.

Antidote.—Inhaling the vapour of ammonia may be serviceable in neutralizing hydrochloric acid gas. Symptoms of bronchial inflammation are of course to be treated in the usual way.

2. Liquid Hydrochloric Acid.

(Acidum Hydrochloricum, *L.* Acidum Muriaticum. *E. D.* (U. S.) Hydrochloric Acid, *E.* Muriatic or Marine Acid; Spiritus Salis, or Spirit of Salt.)

Preparation.—This is obtained by submitting a mixture of Common Salt (chloride of sodium) and Oil of Vitriol to distillation in a proper apparatus, and condensing the Hydrochloric Acid gas which passes over in water contained in the receiver.—Manufacturers of hydrochloric acid generally employ an iron or stoneware pot set in brickwork over a fire-place, with a stoneware head luted to it, and connected with a row of double-necked bottles, made of the same material, and furnished with stop-cocks of earthenware. The last bottle is supplied with a safety tube, dipping into a vessel of water.

The liquid obtained by this process is yellow, and constitutes *Commercial Muriatic Acid* (*Acidum Muriaticum venale; Hydrochloric Acid of Commerce*, Ph. Ed.)

Since the manufacture of carbonate of soda from the sulphate of soda, and the consequent necessity of obtaining the latter salt in large quantities, another mode of making hydrochloric acid has been sometimes adopted. It consists in using a semi-cylindrical vessel for the retort: the upper or flat surface of which is made of stone, while the curved portion exposed to the fire is formed of iron. The chloride of sodium is introduced at one end, which is then closed by an iron plate, perforated to allow the introduction of the leg of a curved leaden funnel, through which strong sulphuric acid is poured. The funnel is then removed, and the aperture closed. Heat being applied, the hydrochloric acid gas is developed, and is conveyed by a pipe into a double-necked stoneware bottle, half filled with water, and connected with a row of similar bottles likewise containing water.

The British Pharmacopœias give directions for making hydrochloric acid. The *Edinburgh College* directs the common salt to be previously purified—

"By dissolving it in boiling water; concentrating the solution; skimming off the crystals as they form on the surface; draining from them the adhering solution as much as possible; and, subsequently, washing them with cold water slightly."

The *London College* uses Chloride of Sodium dried, lbij.; Sulphuric Acid, ℥xx.; Distilled Water, f℥xxiv. The *Edinburgh College* employs equal weights of Purified Salt, Pure Sulphuric Acid, and Water. The *Dublin College* orders of Dried Muriate of Soda, 100 parts; Sulphuric Acid of commerce, 87 parts; and Water, 124 parts. The Chloride of Sodium is to be introduced into a glass retort, and the Sulphuric Acid mixed with part [f℥xij. *L.*; one-third, *E.*; one-half, *D.*] of the Water [and allowed to cool, *E.*] is then poured over the Salt; the remainder of the Water being placed in the receiver. Distillation is then to be effected, [by a sand-bath, *L.*, or by a naked gas-flame, *E.*] so that the gas may pass over into the water contained in the receiver, [which is to be kept cool by snow, or a stream of cold water, *E.*] The Acid thus procured is called, by the Edinburgh College, *Acidum muriaticum purum.*

The *theory* of the above process is precisely that already explained in the manufacture of hydrochloric acid gas (p. 257.) The salt is dried, to expel any water which may be mechanically lodged between the plates of the crystal, and to obtain uniform weights.

The quantity of strong sulphuric acid ($\dddot{S} + \dot{H}$) required to saturate 2 lbs. of common salt is $19\frac{5}{16}$ oz.; so that the London College employs a slight excess only; whereas the Edinburgh College directs a much greater excess.

A pure muriatic acid is obtained in the manufacture of the liquid called *spirit of tin.* Tin is dissolved in commercial muriatic acid, and the solution submitted to heat in green glass retorts: pure muriatic acid distils over, and the residue in the retort constitutes spirit of tin.

PROPERTIES.—Pure liquid hydrochloric acid (*acidum hydrochloricum purum*) is colourless, evolves acid fumes in the air, and possesses the usual characteristics of a strong acid. It has the odour and taste of the gaseous acid. Its specific gravity varies with its degree of concentration. The London College fixes it at 1·16,—The Edinburgh College at 1·170. It is decomposed by some metals (*e. g.* zinc and iron,) hydrogen being evolved, and a metallic chloride formed. It reacts on those oxyacids which contain five equivalents of oxygen each (*e. g.* nitric, chloric, iodic, and bromic acids:) the oxygen of these acids unites with the hydrogen of the hydrochloric acid to form water. When it acts on a metallic oxide, water and a metallic chloride are produced.

Characteristics.—Hydrochloric acid yields, with nitrate of silver, a white, clotty, fusible precipitate (*chloride of silver,*) which is insoluble in nitric acid, soluble in ammonia, and blackens by exposure to light. (See p. 218.) When pure, it is without action on gold leaf, and does not decolourize sulphate of indigo. A rod dipped in a solution of caustic ammonia produces white fumes (*sal ammoniac*) when brought near strong liquid hydrochloric acid.

COMPOSITION.—Liquid hydrochloric acid is composed of *water*, holding in solution *hydrochloric acid gas.* When its sp. gr. is 1·162, its composition, according to Dr. Thomson,[1] is as follows:—

	Atoms.	*Eq. Wt.*	*Thomson.*
Hydrochloric acid gas	1	37	33·95
Water	8	72	66·05
Liquid hydrochloric acid, sp. gr. 1·162,	1	109	100·00

[1] *An Attempt to establish the First Principles of Chemistry*, vol. i. p. 87. Lond. 1825.

In the London Pharmacopœia it is stated that one hundred and thirty-two grains of crystallized carbonate of soda, saturate 100 grains of acid, sp. gr. 1·16. This would indicate a per-centage strength of 33·916.

DR. THOMSON'S TABLE, EXHIBITING THE SPECIFIC GRAVITY OF HYDROCHLORIC ACID OF DETERMINATE STRENGTHS.

Atoms of Water to one of Acid.	*Real Acid in 100 of the Liquid.*	*Specific gravity.*	*Atoms of Water to one of Acid.*	*Real Acid in 100 of the Liquid.*	*Specific gravity.*
6	40·659	1·203	14	22·700	1·1060
7	37·000	1·179	15	21·512	1·1008
8	33·945	1·162	16	20·442	1.0960
9	31·346	1·149	17	19·474	1.0902
10	29·134	1·139	18	18·590	1·0860
11	27·206	1·1285	19	17.790	1·0820
12	25·517	1·1197	20	17·051	1·0780
13	24·026	1·1127			

PURITY.—*Pure hydrochloric acid* (*acidum hydrochloricum purum*) is colourless, or nearly so, without action on gold leaf, and, when diluted with distilled water, is not altered by a solution of chloride of barium. *Commercial hydrochloric acid* (*acidum hydrochloricum venale*) is yellow, and contains usually sesquichloride of iron and sulphuric acid; and sometimes chlorine, nitrous acid, (or some other oxide of nitrogen,) and perhaps bromine. The Edinburgh College fixes its density at 1·180.

The presence of *iron* is shown by saturating the acid with carbonate of soda, and then applying tincture of nutgalls, which produces a black tint. Another mode is to supersaturate the liquid with ammonia or its sesquicarbonate, by which the red or sesquioxide of iron will be precipitated.

If the liquid acid contain either *free chlorine* (or *bromine*) it will possess the power of dissolving leaf-gold, or even of decolourizing a small quantity of sulphate of indigo. A solution of protochloride of tin is the readiest test for detecting any gold, which may be dissolved, with which it forms a purplish or blackish precipitate.

Sulphuric acid (free or combined) may be detected by adding to the suspected acid a solution of chloride of barium (or nitrate of baryta:) if sulphuric acid be present, a heavy white precipitate of sulphate of baryta is procured, which is insoluble in nitric acid. In applying this test, the suspected acid should be previously diluted with five or six times its volume of water; otherwise a fallacy may arise from the crystallization of the chloride of barium.

Nitrous acid (or some other oxide of nitrogen) is recognisable by protosulphate of iron (See Nitric Acid.)

PHYSIOLOGICAL EFFECTS.—α. *On Dead Animal Matter.*—Very dilute hydrochloric acid, mixed with dried mucous membrane, has the property of dissolving various animal substances (as coagulated albumen, fibrin of the blood, boiled meat, &c.,) and of effecting a kind of artificial digestion of them, somewhat analogous to the natural digestive process. (Müller, *Elements of Physiology*, p. 544.)

β. *On Animals.*—The effects of liquid hydrochloric acid on living animals (horses and dogs) have been investigated by Sproegel, Courton, Viborg, (Wibmer, *Die Wirkung der Arzneimittel und Gifte.*) and by Orfila. (*Toxicologie Générale.*) Thrown into the veins it coagulates the blood, and causes speedy death. Small quantities, however, may be injected without giving rise to fatal results. Thus Viborg found that a horse recovered in three hours from the effects of a drachm of the acid diluted with two ounces of water, thrown into a vein. Administered by the stomach to dogs, the undiluted acid acts as a powerful caustic poison. Exhalations of the acid vapours take place through the mouth and nostrils, and death is generally preceded by violent convulsions.

γ. *On Man.*—Properly diluted, and administered *in small but repeated doses*, hydrochloric acid produces the usual effects of a mineral acid before described (pp. 189, 192, 198, and 207:) hence it is tonic, refrigerant, and diuretic. It usually causes a sensation of warmth in the stomach, relaxes the bowels, and increases the frequency of the pulse. *Larger doses* are said to have excited giddiness and a slight degree of intoxication or stupor. In a *concentrated form* it operates as a powerfully caustic poison. The only recorded cases of poisoning by it (in the human subject) with which I am acquainted, are one mentioned by Orfila (*Toxicolog. Générale.*) and another related by my friend and former pupil, Mr. John Quekett. (*London Medical Gazette*, vol. xxv. p. 285, November, 15, 1839.) In the latter case the stomach and duodenum were found, after death, to be charred, and the gall bladder was observed to have a green tint at the part where it was in contact with the stomach [from the action of the acid on the bile?]. It is remarkable that the contents of the stomach manifested no acidity to litmus; nor could any chloride be recognised by nitrate of silver, either in the decoction of the stomach and duodenum, or in the contents of the stomach. The particular nature of the chemical changes effected by it in the organic tissues with which it comes in contact, is not so well understood as in the case of sulphuric or nitric acid. Its chemical action is less energetic than either of the acids just mentioned.

Uses. α. *Internal* or *Remote.*—Hydrochloric acid has been employed in those diseases formerly supposed to be connected with a putrescent condition of the fluids; as the so-called putrid and petechial fevers, 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 deposites 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, (*Lond. Medical Review*, vol. ii. p. 278. Lond. 1800.) in hepatic disorders, &c.

β. *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. Van Swieten (*Commentaries*, Eng. Transl. vol. iv. p. 31. Edinb. 1776.) employed it in cancrum oris; and, more recently, Bretonneau[1] has spoken in the highest terms of its efficacy in angina membranacea, commonly termed diphtheritis. It is applied to the throat by a sponge. 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 frost-bitten parts, to chilblains, &c. An injection composed of from eight to twelve drops of the acid to three or four ounces of water, has been employed as an injection in gonorrhœa. In those forms of dyspepsia accompanied with or dependent on a deficiency of this acid in the gastric juice, it is calculated to prove serviceable.

Administration.—It is given, properly diluted, in doses of from five to fifteen or twenty minims.

---

[1] *Recherches sur l'Inflammation spéciale du tissu muqueux, et en particulier sur la diphthérite, angine maligne, ou croup épidémique.* Paris, 1826.

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

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

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

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

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

1. NITROGEN'IUM.—NITROGEN.

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

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

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

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

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

1 eq. Nitrogen = 14

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

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

PHYSIOLOGICAL EFFECTS.—The effects of nitrogen gas on vegetables and animals are analogous to those of hydrogen before mentioned. (See p. 238.) Thus,