Two drops occasioned nausea, hiccup, and increased secretion of mucus.

The constitutional effects resulting from the continued use of bromine have not been determined. They are probably analogous to those of iodine.

Hitherto no cases of poisoning with it in the human subject have been seen.

USES.—It seems to possess the same therapeutic influence as iodine, and has been administered in bronchocele, in scrofula, in tumors, in amenorrhœa, and against hypertrophy of the ventricles. It is usually regarded as possessing more activity than iodine.

ADMINISTRATION.—It may be administered dissolved in water. An aqueous solution, composed of one part by weight of bromine and forty parts of water, may be given in doses of five or six drops properly diluted and flavoured with syrup. This solution has also been used as an external agent in lotions.

The bromides of potassium, iron, and mercury, have been employed in medicine, and will be described hereafter. An ointment containing bromide of potassium and liquid bromine has been used, and will be noticed when speaking of the bromide.

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.

ORDER 5.—HYDROGEN, AND ITS COMPOUNDS WITH OXYGEN AND CHLORINE.

Hydroge'nium.—Hy'drogen.

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 ὕδωρ, *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.

(*a.*) *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.

(*b.*) *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 both night and day hydrogen gas (Decandolle, *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.

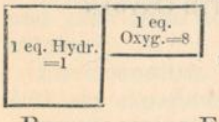
Add some granulated zinc to a mixture of 1 part sulphuric acid and 5 or 6 parts of water by measure. One equivalent or 32 parts of zinc decompose one equivalent or 9 parts of water, and unite with one equivalent or 8 parts of the oxygen, forming one equivalent or 40 parts of the oxide of zinc, while 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.

INGREDIENTS USED.			PRODUCTS.	
1 eq. Water . 9	1 eq. Hydrogen 1		1 eq. Hydrogen .	1
	1 eq. Oxygen . . 8	1 eq. Oxide Zinc 40		
1 eq. Zinc 32				
1 eq. Sulphuric Acid 40			1 eq. Sulp^te. Zinc	80

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.

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. (*a.*) *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 (*ibid.* p. 105,) but an aqueous solution of it seems to be inert (Decandolle, *Physiol. Végét.* t. iii. p. 1360). It has been said that when plants are made to vegetate in the dark their etiolation 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*, 6th ed. p. 347-8.)

(*b.*) *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.)

(*c.*) *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 shew that his lungs contained very little atmospheric air he applied his mouth to a tube, blew out the air, 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 shewn 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.—(*a*). 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 hyperoxygenised. The inhalation was continued for about fifteen minutes, and repeated several times in the day (*New Method of treating Pulmonary Consumption*). Ingenhousz fancied that it had a soothing effect when applied to wounds and ulcers.

(*b*.) In *rheumatism and paralysis* it has been used by Reuss as a resolvent.

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

(*d*.) *Hydrogen water* (an aqueous solution, prepared by artificial pressure) has been employed in diabetes (*ibid*).

A'qua.—Water.

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.

Natural History.—(*a*.) *In the inorganized kingdom.* Water exists in the atmosphere; 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 or 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. 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 32,058,939$\frac{3}{4}$ 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*.

(*b.*) *In the organized kingdom*, water is an essential constituent of vegetables and animals.

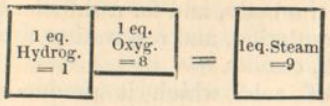
Preparation.—Absolutely pure water may be procured by combining its elements. For all practical purposes it is obtained sufficiently pure by the distillation of common water. But water which has been repeatedly distilled gives traces of acid and alkali when examined by the agency of galvanic electricity. Distilled water remains unchanged on the addition of any of the following substances:—solutions of the caustic alkalies, lime water, oxalic acid, the barytic salts, nitrate of silver, and solution of soap. If any turbidness, milkiness, or precipitate, be occasioned by any of the above, we may infer the existence of some impurity in the water. But the most delicate test of the purity of water is galvanism, as before mentioned. The purest natural water is snow and rain water; then follow river, spring, and well waters.

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, 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·. 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 0·624 (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 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 crystallizatian*. 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 recognized 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.

Composition.—The composition of water is determined both by analysis and synthesis. If this liquid be submitted to the influ-

ence 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.



	Eq. or At.	Eq. Wt.	Per Cent.	Berz.&Dulong.		Vol.	Sp. Gr.
Hydrogen	1	1	11·11	11·1	Hydrogen gas	1	0·0694
Oxygen	1	8	88·88	88·9	Oxygen gas	0·5	0·5555
Water	1	9	100·00	100·0	Aqueous vapour	1	0·6249

PHYSIOLOGICAL EFFECTS.—Water is a vital stimulus; that is, it is one of the external conditions essential for the manifestation of life. It constitutes four-fifths of the weight of the tissues, and is the source of their physical properties, extensibility and flexibility. Considered in a *dietetical* point of view, it serves at least three important purposes in the animal economy: namely, it repairs the loss of the aqueous part of the blood, caused by the action of the secreting and exhaling organs; secondly, it is a solvent of various alimentary substances, and, therefore, assists the stomach in the act of digestion, though, if taken in very large quantities, it may have an opposite effect, by diluting the gastric juice; thirdly, it is probably a nutritive agent, that is, it assists in the formation of the solid parts of the body.

In a *medicinal* point of view, the physiological effects of water are much modified by its temperature.

(*a.*) *Effects of tepid water.*—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 cause difficulty of breathing and an apoplectic condition. Thrown with force into the carotid artery it kills by its mechanical effect on the brain. I have already (p. 23) made some observations on the action of water on the sanguineous globules out of the body.

(*b.*) *Effects of ice, snow, and ice-cold water.*—The temperature of these agents is not higher than 32° F. When brought in contact with a living part, they produce two series of effects—the first of which may be denominated *direct, primary*, or *immediate;* while the second may be termed *indirect, secondary*, or *mediate*, since they are developed by the vital actions, after the cold agent has ceased to act.

a. Of the primary effects.—When ice is applied to the body, it abstracts heat, causes pain, reduces the volume of the part, and diminishes

vital action ; and, if applied for a sufficient period, occasions mortification —an effect which is hastened by the previously weakened condition of the part. If applied to a large surface of the body, and for a sufficient length of time, the processes of secretion, circulation, and respiration, are checked, and stupefaction, followed by death, ensues.

When taken *internally*, the sensation of cold which it produces is not so obvious as that occasioned by its external application; and the effect is more temporary, from the greater heat of the internal parts, by which the ice is sooner melted, and the resulting liquid quickly raised to the temperature of the body. If, however, it be taken in large quantity, the effects are of the same general kind as those already described; namely, a sensation of cold in the epigastrium, sometimes attended with shivering ; diminished frequency of pulse ; temporary contraction of the alimentary canal; diminution of irritability, and of secretion. Employed in small quantities, these effects are not at all perceived, or are only momentary; and the second stage, or that of reaction, almost immediately follows. Baglivi (quoted by Wibmer) found that the injection of four ounces of cold water into the jugular vein of a dog caused shivering of the whole body.

β. Secondary effects.—When the application of cold is temporary, more especially if the subject be young and robust, reaction follows the removal of the cold agent. The vascular action of the part is increased, the pulse becomes full and more frequent, and the animal heat is restored to its proper degree, or is even increased beyond its natural standard. These effects, more or less modified, are observed both from the internal and external employment of ice. Thus, after the internal use of it, a feeling of warmth at the epigastrium soon succeeds that of cold, and this extends shortly over the whole body; the secretions of the alimentary canal, of the kidneys, and of the skin, are increased ; and the circulation is accelerated. Sometimes these secondary effects are attended with those of a morbid character: thus, inflammation of the stomach has been brought on by the employment of ice.

γ. Effects of hot, but not scalding, water.—Hot, but not scalding, water increases the temperature and volume of living parts, relaxes the tissues, and augments vital activity. Applied to the skin it causes rubefaction.

δ. Effects of boiling water and steam.—Both of these are local irritants, and, if sufficiently long applied, caustics, giving rise to extensive and deep eschars. Steam contains more specific heat than boiling water, but its conducting power is less than the latter.

Uses.—These may be subdivided into internal and external.—I. *Internal.* (*a.*) *Of ice and ice-cold water.*—Sometimes we administer ice internally, for the purpose of obtaining its primary effects: thus, in hæmorrhage from the stomach we use it for the purpose of causing contraction of the vessels of the gastric surface, and thereby of checking or stopping sanguineous exhalation. So also in violent pulmonary, or bronchial, or nasal hæmorrhage, ice-cold water, taken into the stomach, has been found beneficial. In most cases, however, we use it on account of its secondary effects. Thus, in relaxed and atonic conditions of the stomach—in dyspepsia and cardialgia, it is employed to check vomiting, and to allay spasmodic pain. In those forms of fever deno-

minated putrid, the internal use of small quantities of ice is sometimes highly serviceable.

(*b.*) *Of cold water.* α. *Taken into the stomach.*—Cold water was employed as a drink in fevers in the time of Hippocrates, who, as well as Celsus, Galen, and other ancient writers, strongly recommended its use. Celsus, in speaking of ardent fever, says, "Cum vero in summo incremento morbus est, utique non ante quartum diem, magna sit antecedente, frigida aqua copiose præstanda est, ut bibat etiam ultra satietatem."

Cold water constitutes the *febrifugum magnum* of Dr. Hancock. We are indebted to Dr. Currie for examining the circumstances under which its exhibition is proper. According to him, it is inadmissible during the cold or sweating stage of fever, but may be employed with safety and advantage when the skin is dry and burning. In other words, the regulations for its administration are precisely the same as for the cold affusion presently to be noticed. When exhibited under proper circumstances it acts as a real refrigerant, reducing preternatural heat, lowering the pulse, and disposing to sweating. I ought not, however, to omit noticing, that serious and even fatal consequences have resulted from the employment of large quantities of cold water by persons who have been rendered very warm by exercise and fatigue.

Besides fever, there are many other affections in which cold water is a useful remedy. For example, to facilitate recovery from an attack of epilepsy or hysteria, and also in fainting, a draught of cold water is oftentimes beneficial. There are also various morbid states of the alimentary canal in which cold water may be administered with advantage; as, to diminish irritable conditions of the stomach, and to allay vomiting and gastrodynia. Large quantities of cold water have sometimes caused the expulsion of intestinal worms (both *Tænia* and *Ascaris vermicularis*, or small thread-worms, commonly termed *ascarides*, and which are found in the large intestines of children, particularly in the rectum). Salt-water acts more efficaciously, as I shall hereafter have occasion to notice.

β. *Injected into the rectum.*—Cold water is thrown into the rectum sometimes to check hæmorrhage; to cause the expulsion of worms (the small thread-worm); to allay pain; in poisoning by opium; in inflammation of the bowels; and in various other cases.

γ. *Injected into the vagina.*—Dr. A. T. Thomson speaks very favourably of the effects of cold water when applied in uterine hæmorrhages by means of the stomach pump, and he says he has seen it used in several cases most successfully.

(*c.*) *Tepid and warm water.* α. *Taken into the stomach.*—*Tepid* and *warm* drinks are employed for various purposes; as, for promoting vomiting, to dilute the contents of the stomach and to render them less acrid, as in cases of irritant poisoning; but in poisons acting by absorption, diluents are objectionable, since they facilitate this process, and, therefore, ought not to be given unless vomiting be present, or the stomach-pump be at hand. Warm aqueous drinks are administered with the view of exciting diaphoresis, in gout, rheumatism, catarrh, &c., and to assist their operation the patient should be kept warm in bed, in order to promote the cutaneous circulation. Warm liquids are oftentimes used as emollients; as to allay irritable and troublesome cough, particularly when this appears to depend on irritation at the top of the larynx.

β. Injected into the rectum, warm water is sometimes employed to promote the hæmorrhoidal flux, and thereby to relieve affections of distant organs; as an emollient, to diminish irritation either in the large intestine itself, or in some neighbouring organ, namely, the bladder, prostate gland, or uterus; to promote the catamenial discharge, &c. Clysters of tepid water are frequently employed to excite alvine evacuations. I have before (p. 53) expressed my opinion as to the impropriety of frequently introducing several pints of fluid into the rectum, since the gut, by dilatation, becomes less susceptible to the natural stimulus of the fæces.

γ. Injected into the vagina, warm water may be used to diminish irritation or pain in the womb,—to promote the lochial discharge, &c.

δ. Injected into the bladder, warm water is sometimes employed either to diminish irritation in this viscus, or to distend it previously to the operation of lithotrity.

ε. Injected into the urethra, it has been used to allay irritation, or to check discharges from the mucous membrane.

ζ. Injected into the veins, warm water was proposed by Magendie as a remedy for hydrophobia, but it has neither theory nor experience to recommend it. However, in a disease which has hitherto resisted all known means of cure, practitioners are glad to try any remedy that may be proposed, however improbable, or unlikely of success. I have already (p. 55) mentioned a case in which I tried warm water injections, but without much benefit. Vernière (Christison's *Treatise on Poisons*, p. 35) has proposed to distend the venous system with warm water, to check or stop absorption in poisoning, by those agents whose operation depends on their absorption; for example, opium. I am not acquainted with any case in which it has been tried on the human subject. Warm water is sometimes a medium for the introduction of other more powerful agents into the circulating system; as, for example, tartar emetic.

d. Vapour.—The *inhalation of aqueous vapour* acts as a serviceable emollient in irritation or inflammation of the tonsils, or of the membrane lining the larynx, trachea, or bronchial tubes. It may be employed by means of Mudge's inhaler, or by merely breathing over warm water. Various narcotic and emollient substances are frequently added to the water, without increasing its therapeutical power. In some pulmonary complaints, Dr. Paris states he has been long in the habit of recommending persons confined in artificially warmed apartments to evaporate a certain portion of water, whenever the external air has become excessively dry by the prevalence of the north-east winds which so frequently infest this island during the months of spring; and the most marked advantage has attended the practice.

II. *External.—a. Ice and ice-cold water.*—Ice is sometimes applied externally to check hæmorrhage, more especially when the bleeding vessel cannot be easily got at and tied. Thus, after operations about the rectum (more especially for piles and fistula) hæmorrhage sometimes occurs to a most alarming extent; and in such cases our principal reliance must be on cold. In two instances that have fallen under my own observation, I believe the lives of the patients were preserved by the introduction of ice within the rectum. In many other cases of hæmorrhage, the external application of cold (either in the form of ice or ice-cold water) is exceedingly useful. Thus, applied to the chest in

dangerous pulmonary hæmorrhage, to the abdomen in violent floodings, it is oftentimes most beneficial. In some of these cases, especially in uterine hæmorrhage, more benefit is obtained by pouring cold water from a height, than by the mere use of ice.

Pounded ice, tied up in a bladder, has been applied to hernial tumors, to diminish their size and facilitate their reduction; but notwithstanding that the practice has the sanction and recommendation of Sir Astley Cooper, it is, I believe, rarely followed, not having been found successful; and if too long continued, it may cause gangrene. In this, as well as in other cases where ice or snow cannot be procured, a freezing mixture may be substituted. For this purpose, five ounces of muriate of ammonia, five ounces of nitre, and a pint of water, are to be placed in a bladder, and applied to the part. Ice has also been applied in prolapsus of the rectum or vagina, when inflammation has come on which threatens mortification.

In inflammation of the brain, ice, pounded and placed in a bladder, may be applied to the head with a very beneficial effect. In fever also, where there is great cerebral excitement, with a hot dry skin, I have seen it advantageously employed. In apoplexy, likewise, it might be useful. In the retention of urine to which old persons are liable, ice-cold water applied to the hypogastrium is sometimes very effective, causing the evacuation of this secretion.

In the above-mentioned local uses of ice, we either apply it directly to the part, or inclose it in a bladder: the latter is to be preferred, since the patient is not wetted with the melted water, while the effect is less violent.

In the last place, I must notice the employment of ice or snow in the form of *friction*. Whenever it is used in this way, the ultimate object is the production of the secondary effects, or those which constitute the stage of reaction. Thus this practice has been resorted to in diminished sensibility of the skin, in the rheumatism or gout of old and enfeebled persons, in order to produce excitement of the skin; but its most common use is as an application to parts injured by cold. The affection thus induced is called *pernio*, or the *chilblain;* and the parts affected are said to be *frost-bitten*. The feet, hands, tip of the nose, and pinna of the ear, are the organs most frequently attacked. Now, with the view of preventing the mortification and other ill consequences arising from the application of cold, great care must be used to avoid sudden changes of temperature. The frost-bitten part, or the chilblain, should be rubbed with snow or pounded ice, or bathed in ice-cold water, very gradually raising the temperature of the applications until the part acquires its natural heat.

(*b.*) *Cold, cool, tepid, and hot water.*—Water of various degrees of temperature is employed for baths, affusion, washing or sponging, the *douche*, and for various local purposes.

a. Baths.—History.—The practice of bathing is of great antiquity, and, in fact, precedes the date of our earliest records. It was employed, sometimes for the purpose of cleanliness, sometimes for the preservation of health, and frequently as a means of sensual gratification. Ablutions were practised by the ancient Hebrews, as you will find mentioned in the Old Testament. Baths were used by the Egyptians, as well as by the

Hindoos, the Syrians, the Medes, the Persians, and other inhabitants of the East. The most ancient of the Greek writers also frequently mention them: thus Homer speaks of them in the Iliad and Odyssey. In the writings attributed to Hippocrates, you will find baths alluded to, and their effects noticed. Celsus describes the different parts of baths, and the mode of employing them; but the best description will be found in the works of Galen.

The following is a sketch of the baths of the Romans, copied from a painting found at the *thermæ* of Titus. (De Montfaucon, *l'Antiquité expliquée et répresentée en figures*, tom. 3me, part 2de, p. 204).

Fig. 37.

Ancient Baths.

On the right is the *eleotherium* (ἀλειπτήριον) where the oils and perfumes are kept in vases: next to this is the *frigidarium* (ἀποδυτήριον) or dressing-room: the third is the *tepidarium:* the fourth is the sudatory (*concamerata sudatio*) in which are seen the *laconicum* (so called from being first used in Laconia) a brazen furnace to heat the room, and persons sitting on the steps: the fifth is the *balneum*, with its huge basin (*labrum*) supplied by pipes communicating with three large bronze vases, called *milliaria*, from their capaciousness; the lower one contained hot, the upper one cold, and the middle one tepid water. The bathers returned back to the frigidarium, which sometimes contained a cold bath. The subterranean portion of the building, where the fires were placed for heating the baths, was called *hypocaustum.*

For further information on the ancient baths, consult "*An Account* of the *Ancient Baths*, by Thomas Glasse, M. D. 1752;" or Dr. Parr's "*Medical Dictionary.*" All the remarks made on baths by the Greeks, Latins, and Arabs, have been brought together in one volume, folio, under the following title:—"*De Balneis omnia quæ extant apud Græcos, Latinos, et Arabos*, 1553."

Effects and uses of baths.—The effects of baths depend, for the most part, on the temperature of the fluid employed, on its conducting power, and, in part also, on its pressure. We may, therefore, conveniently, arrange them thus:—

(*a.*) LIQUID BATHS.

(1.) *The cold bath.*
(2.) *The cool bath.*
(3.) *The temperate bath.*
(4.) *The tepid bath.*
(5.) *The warm bath.*
(6.) *The hot bath.*

(*b.*) VAPOUR BATHS.

Writers are not agreed on the precise temperature of the above baths, but the order in which I have arranged them, according to their respective degrees of heat, is that which is generally admitted.

(1.) *The Cold Bath.*—The temperature of this ranges from 33° F. to

about 60° F.: when it is below 50°, it is sometimes termed a *very cold bath*. The *effects* of immersion in the cold bath are analogous to those already described as being produced by the application of ice or snow to the body, and, therefore, may be conveniently subdivided into primary and secondary.

(*a.*) *Primary effects.*—(*The shock.*)—The sudden abstraction of heat from the surface, and the pressure of the water, produce a powerful shock on the system: a sensation of cold, (speedily followed by a sensation of warmth) contraction of the cutaneous vessels, paleness of the skin, diminution of perspiration, and reduction of the volume of the body, are the immediate effects. Shivering, and, as the water rises to the chest, a kind of convulsive sobbing, are also experienced. Continued immersion renders the pulse small, and, ultimately, imperceptible—the respiration difficult and irregular; a feeling of inactivity succeeds—the joints become rigid and inflexible—pain in the head, drowsiness, and cramps, are experienced—the temperature of the body falls rapidly, and faintness, followed by death, comes on. Many of these symptoms are readily comprehended: the contracted state of the superficial vessels produced by the cold, together with the pressure of the water, causes the blood to accumulate in the internal vessels. The heart makes great efforts to get rid of this increased quantity of blood, and hence palpitations occur; but as the arteries remain contracted, the pulse continues small. The internal veins, therefore, being gorged with blood, the brain necessarily suffers:—hence the headache, the drowsiness, the cramps, and, in some cases, apoplexy. The difficult respiration depends on the accumulation of blood in the lungs. The contracted state of the superficial vessels accounts for the diminished perspiration; while the increased secretion of urine is referrible to the blood being driven towards the internal organs.

(*b.*) *Secondary effects.*—(*Re-action or glow.*)—In general, the immersion being only temporary, re-action quickly takes place; a sensation of warmth soon returns; the cutaneous circulation is speedily re-established; a glow is felt; perspiration comes on; the pulse becomes full and frequent; and the body feels invigorated. In weakly and debilitated subjects, however, this stage of re-action may not occur, or at least may be imperfectly effected; and usually, in such cases, the cold bath will be found to act injuriously.

The *uses* of the cold bath may be in part comprehended from the effects just detailed. It is employed with the view of obtaining one of the three following effects: the nervous impression or shock,—the refrigeration,—the re-action or glow. (*Cyclopædia of Practical Medicine*, art. *Bathing*, by Dr. J. Forbes.) It is evident that it ought not to be applied unless there be a sufficient degree of tone and vigour in the system to cause a perfect state of re-action; and, therefore, in weak subjects, its use is to be prohibited. So also, in visceral inflammation, more especially peripneumonia, it is a dangerous remedy; since the determination of blood to the internal organs is increased by the cold, and it seems even within the range of probability that death might be the result. Apoplectic subjects, who are unaccustomed to cold bathing, had also, for a similar reason, better avoid trying it. In some affections of the nervous system it has been found highly useful; for example, in tetanus and

insanity. So also, in any cases where we wish to increase the tone and vigour of the body, and where the before-mentioned objections do not exist, the cold bath may be used advantageously. It is a common opinion that immersion in cold water is dangerous when the body is heated by exercise, or other exertion; and hence it is customary with bathers to wait until they become cool. Dr. Currie has strongly combated both the opinion and the practice: the first, he says, is erroneous, the second injurious.

(2.) *The Cool Bath* (whose temperature is from 60° to about 75°) is analogous in its operation to the cold bath, but less powerful. It is commonly employed for the purposes of pleasure and cleanliness; but it may be resorted to, therapeutically, in the same diseases as the cold bath, where we are in doubt as to the power of the patient's constitution to establish full re-action. It is frequently used as a preparatory measure to the cold bath.

(3.) The *Temperate Bath* ranges from 75° F. to 85° F. Its effects and uses are similar to the cool bath.

(4.) The *Tepid Bath* gives rise to a sensation of either heat or cold, according to the heat of the body at the time of immersion. The temperature of this bath ranges between 85° and 92°. It cleanses the skin, promotes perspiration, and is used as preparatory to either of the before-mentioned baths. It is said to allay thirst. Where there is a tendency to apoplexy, it has been recommended to immerse the body in the tepid bath, and at the same time to pour cold water over the head.

(5.) The *Warm Bath* varies in its *effects* on different individuals. Its temperature is about that of the body, or a little below it: we may say from 92° to 98°. In general it causes a sensation of warmth, which is more obvious when the body has been previously cooled. It renders the pulse fuller and more frequent, accelerates the respiration, and augments the perspiration. It gives rise to languor, loss of muscular power, faintness, and disposition to sleep. The *uses* of it are various. Sometimes it is employed to cause relaxation of the muscular system; as in dislocation of the larger joints: and also in hernia, to assist the operation of the taxis. In the passage of calculi, either urinary or biliary, it is applied with the greatest advantage: it relaxes the ducts, and thereby facilitates the passage of the foreign body. As a powerful antiphlogistic, it is employed in inflammation of the stomach, bowels, kidneys, bladder, &c. With the view of increasing the cutaneous circulation, it is used in the exanthemata, when the eruption has receded,—and to promote perspiration, in chronic rheumatism, and various chronic skin diseases.

(6.) The *Hot Bath* (the temperature of which is somewhat above that of the body, as from 98° to 112°) gives rise to a sensation of heat, renders the pulse fuller and stronger, accelerates the respiration, occasions intense redness of the skin, and copious perspiration,—causes the vessels of the head to throb violently—brings on a sensation of fulness about the head, with a feeling of suffocation and anxiety,—and, if the immersion be continued, may even induce apoplexy. Being a powerful excitant, it must be used very cautiously. Paralysis, rheumatism, and some chronic diseases, are the principal cases in which it is employed.

(*b.*) The *Vapour Bath.*—The vapour bath differs somewhat in its effects

from the warm or hot bath: hot air and vesicular water being much worse conductors of heat than water in its usual liquid form, the temperature of the bath is neither so quickly, nor so powerfully felt, so that the body can support a higher heat, and for a longer period; moreover, the pressure is less. Dr. Forbes (*Cyclop. Pract. Med.*, art. *Bathing*) gives the following comparative view of the heating powers of water and of vapour, distinguishing the latter according as it is or is not breathed:—

	Water.	*Vapour*	
		Not breathed.	Breathed.
Tepid bath .	85° — 92°	96° — 106°	90° — 100°
Warm bath .	92° — 98°	106° — 120°	100° — 110°
Hot bath . .	98° — 106°	120° — 160°	110° — 130°

The vapour bath acts as a stimulant to the skin; it excites the cutaneous circulation, softens and relaxes the tissue, produces copious perspiration, accelerates the pulse, quickens the respiration, and induces a feeling of languor, and a tendency to sleep. There are two modes of employing it; either by immersing the whole body in the vapour, which is consequently inhaled; or inclosing the body in a chest or box, so that the head is not exposed to the vapour, which, therefore, is not inspired. The aqueous vapour is conveyed into the chamber or box by a pipe communicating with a steam boiler. Sometimes it is made to pass through various vegetable substances, with the odour of which it becomes impregnated, and from which it has been supposed to gain an increase or modification of therapeutical power. These are the *medicated vapour baths*. Sometimes the common vapour bath is accompanied by a process of friction, kneading and extension of the muscles, tendons, and ligaments, constituting the *massing* of the Egyptians, or the *shampooing* of the Indians. Here is the account of the process, as given by Dr. Gibney (*Treatise on the Vapour Bath*, p. 84):—

Fig. 38.

Egyptian Bath.

"After exposure to the bath, while the body is yet warm from the effects of the vapour, the shampooman proceeds, according to the circumstances of the case, from gentle friction gradually increased to pressure, along the fleshy and tendinous parts of the limb; he kneads and grasps the muscle repeatedly, presses with the points of his fingers along its course, and then follows friction, in a greater or less degree, alternating one with the other, while the hand is smeared with a medicated oil, in the specific influence of which the operator has considerable confidence. This process is continued for a shorter or longer space of time, and, according to circumstances, is either succeeded or preceded by an extension of the capsular ligament of each joint, from the larger to the smaller, causing each to crack, so as to be distinctly heard, which also succeeds from the process being extended to each connecting ligament of the vertebræ of the back and loins. The sensation at the moment is far from agreeable, but is succeded by effects

not dissimilar to what arise from brisk electrical sparks, taken from the joints in quick succession."

The application of vapour to particular parts of the body is sometimes accompanied with the simultaneous removal of atmospheric pressure, constituting the *air-pump vapour bath*, which has been employed in cases of gout, rheumatism, and paralysis. I must refer, for a further account of it, to Dr. R. Blegborough's "*Facts and Observations respecting the Air-pump Vapour Bath.*"

The vapour bath is applicable to a great variety of cases, a few only of which can be noticed here. Whenever it is desired to excite the vascular system, more especially the cutaneous portion of it, this remedy may be resorted to with advantage. The cold stage of an intermittent, and malignant cholera, are cases which readily suggest its employment. In rheumatism and gout, in old paralytic cases unaccompanied with signs of vascular excitement about the head, in various atonic affections of the uterine system—such as some forms of chlorosis and amenorrhœa, in dropsy of old debilitated subjects, in various skin diseases, in scrofula, in chronic liver complaints of long standing, &c. this remedy may be employed, and frequently with advantage.

I ought not to leave this subject without alluding to the extensive use made of vapour baths in some parts of the world, particularly Russia, where, we are told, it is customary for the bathers to issue from the bathing-houses while quite hot, and to roll themselves naked in the snow, and then return to the bath, not only without any hurtful, but apparently with beneficial, effects.

β. *Affusion.*—Another mode of employing water externally is by *affusion;* that is, the pouring of water over some portion of the body. It is the κατάχνσις of Hippocrates.

History.—This practice is of very ancient date: as a hygienic agent and luxury it was practised by the Greeks and Orientalists at a very early period, and allusions to it will be found in the Odyssey of Homer. Hot, tepid, and cold affusions, are mentioned by Celsus, in the fourth chapter of the first book, and are recommended in some affections of the head. This last writer also states, that Cleophantus (a physician who lived about 300 years before Christ) employed the affusion of hot water in intermittents. For an account of the effects and uses of cold affusion, I must refer to the *Medical Reports* of Dr. Currie, and to a paper by Dr. Copland, in the *Medical Gazette*, vol. x.

Mode of applying affusion.—In many cases the object is to use affusion to the *head* merely. If the patient be able to sit up, let him incline his head over a large vessel, say a pan or tub, and then pour the water from a height of two or three feet from an ewer or large pitcher. If, however, he be too ill to be removed, he must incline his head over the side of the bed. In children it will be sufficient to squeeze a large sponge at some height above the head, as recommended by Dr. Copland. In some cases it is necessary to guard against the cold water coming in contact with the chest.

When the object is to apply the affusion to the *whole body*, the patient must be placed in a large tub or pan—for example, a bathing-tub or washing-pan—and then an attendant, standing on a chair, may readily effect it. The time that the affusion should be continued will vary according to circumstances, from a quarter to two or three minutes; but

in some cases it has been employed for twenty minutes. After the affusion the body should be carefully wiped dry, the patient wrapped up warm, and placed in bed.

Effects.—The effects of affusion depend partly on the temperature of the water, and partly also on the sudden and violent shock given to the system by the mechanical impulse of the water; hence the reason why the effects vary, according to the height from which the liquid is poured.

1. *Of the affusion of cold water*—that is, of water whose temperature is between 32° F. and 60° F. To a certain extent the effect of this agent is analogous to that of the cold bath, but modified by two circumstances, namely, the short period during which the cold is applied, and the mechanical influence of the stream: hence, its primary effects are very transient, and re-action follows very speedily. By a long continuance of affusion, however, the heat of the body is very considerably reduced, and the same diminution of vital action occurs as when the cold bath is employed. The sensation of cold, the constriction of the skin, and the contraction of the superficial vessels, first experienced in the part to which the water is applied, is very speedily communicated to the rest of the system by sympathy, in consequence of the shock; the effects of which are perceived in the nervous, vascular, secreting, and cutaneous systems. The temperature of the whole body falls, the pulse becomes reduced in volume and frequency, the respiration is irregular, and convulsive shiverings take place, faintness, and, in fact, all the effects already described of the cold bath are produced. During this condition the excretions are suspended. "When," says Dr. Copland, "the stream of water is considerable, and falls from some height upon the head, the effect on the nervous system is often very remarkable, and approaches more nearly than any other phenomenon with which I am acquainted to electro-motive or galvanic agency."

After the affusion, re-action is soon set up, the heat of the body is re-established, the pulse becomes full and regular, though sometimes reduced in frequency, the thirst is diminished, and frequently perspiration and tendency to sleep are observed.

Cold affusion is used principally in those cases where it is considered desirable to make a powerful and sudden impression on the system: for as a mere cooling agent it is inferior to some other modes of applying water. Thus it is employed, for the most part, in fevers, and affections of the nervous system. It is objectionable in visceral inflammation, on account of the determination of blood which it produces to the internal parts. Cold affusion has been employed with great benefit in *fevers*, both continued and intermittent. It may be used with safety, according to Dr. Currie and others, "when there is no sense of chilliness present, when the heat of the surface is steadily above what is natural, and when there is no general or profuse perspiration." It is inadmissible during either the cold or the sweating stage of fever, as also in the hot stage, when the heat is not greater than ordinary. In some instances it seems to act by the shock it communicates to the system; for the effect is almost immediate, the disease being at once cut short. The patient has fallen asleep immediately afterwards, profuse perspiration has succeeded, and from that time recovery begun to take place. This plan of extinguishing a fever, however, frequently fails; and in that event the patient

may be in a worse condition; hence the practice is not often adopted. I think the cases best adapted for the use of cold affusion are those in which there is great cerebral disorder,—either violent delirium or a soporose condition. My friend, Dr. Clutterbuck, (*Inquiry into the Seat and Nature of Fever*, 2d ed. p. 451), says he has seen pulmonic inflammation and rheumatism brought on by cold affusion in typhus; but he adds, "I have not, in general, observed that the situation of the patient was rendered materially worse by the combination."

In the *exanthemata*, cold affusion has been applied during the fever which precedes the eruption, as also after this has been established; it has been used in scarlet fever, and also in small-pox; likewise in measles; but its employment in the latter disease is objectionable, on account of the tendency to pulmonary inflammation, in which cold affusion is prejudicial.

Croup is another disease in which cold affusion has been used with advantage, principally with the view of removing the spasm of the glottis, which endangers the life of the patient.

In *inflammatory affections of the brain*, especially of children, after proper evacuations have been made, it is useful. In many cases of *narcotic poisoning*, cold affusion is of the greatest service; as in poisoning with hydrocyanic acid, and in asphyxia caused by the inhalation of carbonic acid; so also in poisoning with opium, belladonna, and other narcotic substances, in intoxication, in asphyxia from the inhalation of sulphuretted hydrogen gas or of the vapours of burning charcoal, this practice is most advantageous. In *hysteria* and *epilepsy* it is oftentimes serviceable: it diminishes the duration of the paroxysms, and relieves the comatose symptoms. In *puerperal convulsions* Dr. Copland relies on cold affusion and blood-letting. In *mania* it is oftentimes serviceable; as also in *tetanus*.

2. *Cool affusion* has been employed instead of the cold; and in weak irritable subjects it is always preferable. Dr. Currie regards it as a milder form of the cold affusion, as a preparatory means to which it is sometimes used. It has been applied in febrile diseases and paralysis.

3. *Tepid affusion.*—The affusion of tepid water is frequently resorted to as a substitute for that of cold water, where great dread is entertained of the latter agent, or where there is doubt as to the production of a perfect reaction after the application of cold water, or where there is some pulmonary disease. It may be regarded as a safer, though less powerful means. Thus it is very useful in febrile complaints, especially of children. It is very beneficial in scarlet fever, as I have seen on several occasions. Dr. Currie thinks that it reduces the temperature more than cold affusion; first, because the evaporation is greater; secondly, because it does not excite that reaction by which heat is evolved. It diminishes the frequency of the pulse and of respiration, and causes a tendency to sleep. The same writer tells us that he has not found its effects so permanent as those of the cold affusion; and that he never saw it followed by the total cessation of regular fever. In other words, it produces a much less powerful shock to the system, and therefore is less influential over disease. In hectic fever, however, the paroxysm is sometimes completely extinguished by the affusion of tepid water at the commencement of the hot stage.

4. *Warm affusion* excites very pleasant sensations, but which are soon

followed by chilliness, and oftentimes by pulmonary affections. It has been used in mania with advantage: it reduces the frequency of the pulse and of respiration, and occasions a tendency to repose; but the effects are much more temporary than those produced by the warm bath.

γ. *Washing or sponging.*—Cold, cool, or tepid washing or sponging, may be used in febrile diseases, with great advantage, in many cases where affusion is not admissible, or where timidity on the part of the patient or practitioner prevents the employment of the latter. Dr. Currie remarks, that in all cases of fever where the burning heat of the palms of the hands and soles of the feet is present, this method of cooling them should be resorted to. A little vinegar is frequently mixed with the water, to make the effect more refreshing. Washing or sponging must be effected under precisely the same regulations as those already laid down for affusion.

δ. *Shower bath.*—The shower bath is similar in its effects to affusion, but milder in its operation, and is mostly employed in chronic diseases, or as a hygienic agent. In various affections of the nervous system, more especially insanity, it is very useful. In many cases it is a valuable agent when we are afraid to venture on the common cold bath or cold affusion, since it is less likely to cause cramps or other symptoms indicative of a disordered state of the nervous system.

ε. *The Douche.*—The French word *douche*, or the Italian *doccia*, signifies a continued current of fluid applied to, or made to fall on, some part of the body. Dr. Parr states that it is synonymous with our word "*pumping*," and with the Latin word *stillicidium*. At Bath, for example, the waters are applied, say to a paralyzed part, by means of a pump, and the degree or quantity of the application is determined by the number of times the handle is raised or depressed. The water, however, does not issue in gushes, but in a continuous stream. This is evidently what the French would call a *douche*, but our word "pumping" is not applicable to a "*douche de vapeur*." According to the direction in which the water is applied we have the *douche descendante*, *douche latérale*, and *douche ascendante*.

History.—It is uncertain at how early a period this remedy was in use. The following passage from Cælius Aurelianus has been supposed by some to refer to this mode of employing water. "Item *aquarum ruinis* partes in passione constitutæ sunt subjiciendæ, quas Græci κατακλυσμοὺς appellant, plurimum etinim earum *percussiones* corporum faciunt mutationem." By others, however, this passage is supposed to refer to affusion.

General operation.—The effects of the douche depend on several circumstances; such as the nature of the fluid employed, whether vapour or liquid, and if liquid, whether simple or some saline water: the temperature also must have an influence, as is very evident,—the size and direction of the jet, the force with which it is applied, and its duration. At Bath, Dr. Falconer tells us, "from 50 to 200 strokes of the pump is the number generally directed to be taken at one time, which, however, may be increased or diminished according to the age, sex, strength, or other circumstances of the patient." On the continent it is rarely employed for a longer period than 15 or 20 minutes.

The *vapour douche* is nothing more than a jet of aqueous vapour directed on some part of the body, its action depending principally on

the temperature of the fluid, since its mechanical effects are comparatively slight. In the *common vapour douche* the temperature of the aqueous vapour does not exceed that employed in the vapour baths already described; and in such cases it may be regarded as a kind of local vapour bath. Thus in some affections of the ear, as otitis, otorrhœa, and otalgia, a stream of aqueous vapour may be applied to the meatus auditorius externus with great benefit; and the most ready means of effecting this is by a funnel inverted over a vessel of hot water, the ear being placed over the orifice of the funnel.

Sometimes *steam* has been used—that is, aqueous vapour heated to 212° F.; and, of course, it acts as a caustic if sufficiently long applied, causing sometimes an extensive and deep eschar. In this respect its action is similar to that of boiling water, from which, indeed, it principally differs in the circumstance of having a much larger quantity of specific heat, and in the great facility with which we can localize its effects. It may be readily applied to any part of the body by means of a small boiler (copper or tin), furnished with a pipe and stop-cock, and heated by a spirit lamp. It has been used as a powerful counter-irritant in diseases of the hip-joint, neuralgic pains, chronic rheumatism, &c.; but the objections to its use are the great pain and the danger of its employment; for it is a more painful application than many other modes of causing counter-irritation, while its effects are inconstant.

The action of the *liquid douche* depends in a great measure on the temperature of the liquid, but in part also on the mechanical action of the water. This effect of percussion is common to both the cold and hot douche, and by continuance excites pain and inflammation of the part. This local excitement is observed almost immediately when hot water is employed, but takes place more slowly when we use cold water; indeed, the long action of a stream of cold water may act as a sedative, and cause all the effects which I have already described as the primary effects of cold applications.

The effect of the douche is, however, not altogether local, since the neighbouring parts, and even the whole animal economy, soon become affected. A column of water twelve feet high, made to fall perpendicularly on the top of the head, excites such a painful sensation, that, we are told, the most furious maniacs who have once tried it may sometimes be awed merely by the threat of its application; and hence one of its uses in madness, as a means of controlling the unfortunate patient.

The *cold douche* is applicable to those cases of local disease requiring a powerful stimulus. For example, chronic affections of the joints, of long standing, whether rheumatic, gouty, or otherwise, paralytic affections of the limbs, old glandular swellings, and those forms of insanity in which there are no marks of determination of blood to the head. The *warm* douche may be employed in similar cases.

For a variety of local purposes, a syringe is employed to throw a jet of water on particular parts, as into sinuous ulcers, or into the vagina, into the ear, into the rectum, &c., constituting thus a kind of douche.

ζ. *Local uses.*—*Hot*, *warm*, and *cold* water, applied to particular parts of the body, may be regarded as local baths. *Cold water* is applied to produce evaporation, and thereby to generate cold, with the view of relieving local irritation and inflammation. In ophthalmia, phrenitis, and even in gout (though in the latter complaint the practice has been

objected to), cold water lotions are employed with great advantage. One method of treating burns is by the application of cold water, and, if I am to judge by my own sensations, it is by far the most agreeable. By some, however, *warm water* is employed as an emollient application in burns and scalds. This is the practice of my friend Mr. Luke, one of the surgeons to the London Hospital. (*Med. Gaz.* vol. xviii. p. 7).

Warm fomentations and poultices (made of bread or linseed meal) may be regarded, in reference to their effects, as a local bath.

Boiling water is employed externally as a powerful irritant and a speedy vesicant; its action being in this respect analogous to steam, already noticed, and objectionable on the same ground, namely, the great pain, and the uncertainty of its effects; in addition to which may be mentioned, the difficulty of localizing its action. When applied in diseases of internal organs, it may be regarded as a powerful counter-irritant.

III. PHARMACEUTICAL USES.—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 of pharmaceutical nomenclature, *hydroliques* or *hydrolica* (*Pharm. Nomenclat.* of MM. Chereau and Henry, in the *Supplement* to the *Edinb. New Dispens.* p. 152). Those prepared by solution or mixture are called *hydrolés*; and others, procured by distillation, are denominated *hydrolats*.

1. *Hydrolés.*—Cottereau (*Traité Elém. de Pharmacologie*, 1835), divides these into three classes; α. *Mineral hydrolés* (*hydrolés chimico-basiques*), of which Goulard-water and lime-water are examples; β. *vegetable hydrolés* (*hydrolés phytobasiques*), as almond emulsion, mucilage, vegetable infusions, and decoctions, &c.; γ. *animal hydrolés* (*hydrolés zoobasiques*), as broths.

2. *Hydrolats.*—These are the *aquæ distillatæ* of the British Pharmacopœias: as *aqua menthæ piperitæ*, called, in the French codex, *hydrolatum menthæ piperitæ*.

A'quæ Minera'les.—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. 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. 1^er^. 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.

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.*).

Fig. 39.

New Geyser.

The *Geysers*, or boiling springs, of Iceland, are evidently connected with volcanic action. They are intermittent fountains, which throw up boiling water and spray to a great height into the air. For further information concerning them, I must refer to Sir G. S. Mackenzie's "*Travels in Iceland during the Summer of* 1810," and to Barrow's "*Visit to Iceland, by way of Tronyem, &c., in the Summer of* 1834."

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 nonpyrites): 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 (Bertholett, *Essai de Statique Chimique*, 1^er^. 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 shew, 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, ferruginous, or martial waters.* (*Aquæ minerales ferruginosæ; aquæ martiales*).—Oxide of iron is a constituent of most mineral waters, and when the quantity is considerable, the term *chalybeate* is applied to them. Chalybeate waters have an inky, styptic taste, and the property of becoming purplish black on the addition of tannic or gallic acids, or of substances which contain these, as the infusion of galls or of tea. If the iron be in the state of sesquioxide, the ferrocyanide of potassium causes a blue, and sulphocyanide of potassium a red colour.

Most chalybeate waters contain the carbonate of the protoxide of iron; and are termed *carbonated-chalybeates.* Such waters, when exposed to the air, evolve carbonic acid, attract oxygen, and deposit the sesquioxide of iron. By boiling also, the whole of the iron may be precipitated as sesquioxide. When the protocarbonate of iron is associated with a considerable quantity of free carbonic acid, the waters are termed *acidulous-carbonated-chalybeates*, or simply *acidulous-chalybeates;* as the celebrated waters of Spa in Belgium. When a carbonated-chalybeate contains alkaline and earthy salts, but not much free carbonic acid, it is termed a *saline-carbonated-chalybeate;* as the waters of Tunbridge Wells, Oddy's saline chalybeate at Harrowgate, and the Islington Spa near London.

In some cases the oxide of iron is in combination with sulphuric acid: these waters might be termed, in contradistinction to the above, *sulphated-chalybeates.* Exposure to the air, or boiling, does not precipitate all the iron, and in this they are distinguished from the carbonated-chalybeates. The sulphated-chalybeates usually contain sulphate of alumina, and, in that case, are termed *aluminous-chalybeates:* of these, the Sand Rock Spring, Isle of Wight, the strong Moffatt Chalybeate, and Vicar's Bridge Chalybeate, are examples: the last-mentioned is probably the strongest chalybeate in existence.

The effects of chalybeate waters are analogous to those of other ferruginous compounds which I shall have occasion to notice in a subsequent part of this work, and to which, therefore, I must refer for further information. I may, however, mention here that these waters are tonic, stimulant, and astringent, and produce blackening of the stools. The acidulous-carbonated-chalybeates sit more easily on the stomach than other ferruginous agents, in consequence of the excess of carbonic acid present. 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 state of system denominated anæmia. It is contra-indicated in plethoric, inflammatory, febrile, and hæmorrhagic conditions.

Class 2. *Sulphureous or hepatic waters.* (*Aquæ minerales*

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; those of Scotland are Moffatt and Rothsay; of the continent, Enghien, Baréges, Aix, and Aix-la-Chapelle.

The general operation of these waters is stimulant. 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 system.

Class 3. *Acidulous or carbonated waters.* (*Aquæ minerales 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 and 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 or 60 cubic inches of gas are considered rich; but the richest have from 100 to 200 or more cubic inches (Gairdner, *op. cit.* p. 30). Alibert (*Nouveaux Elémens de Thérapeutique*, tom. 3me. p. 517, 5me. ed.) states, that the waters of Saint Nectaire contain 400 cubic inches in 100 of the water. This is the richest of all the acidulous springs.

Some of the waters of this class contain carbonate or bicarbonate of soda: these are termed *acidulo-alkaline*. Frequently they contain carbonate of the protoxide of iron also.

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*).

Those acidulous waters which owe their medicinal activity principally to the carbonic acid which they contain, act chiefly on the digestive and nervous systems, but their effects are transient. They stimulate the stomach and relieve nausea. 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 are useful in the lithic acid diathesis, in gout and rheumatism, &c. The acidulous or carbonated waters are objectionable, on account of their stimulant effects, in febrile, inflammatory, and plethoric subjects.

Class 4. *Saline mineral waters* (*Aquæ minerales 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 operations 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, and Seidlitz. The springs of Cheltenham, Leamington, 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, hæmorrhoids, determination of blood to the head, &c.

Order 2. *Saline* or *brine waters.*—The characteristic ingredient of these waters is chloride of sodium. Iodine or bromine has been recognized in some of them, and doubtless contributes 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.

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 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 con-

tinued 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. The water of Bristol Hotwell is taken in dyspeptic complaints and pulmonary consumption.

Order 4. *Alkaline waters.*—The mineral waters denominated alkaline contain carbonate or bicarbonate of soda as their characteristic ingredient. 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 and Seltzer), are denominated acidulo-alkaline, and are classed with the acidulous or carbonated waters. Those in which carbonate of soda is associated with protocarbonate of iron and excess of carbonic acid (as Spa water), are termed chalybeate waters. The only waters in this country which contain carbonate of soda are those of Malvern, 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 (See Dr. Black's analysis, in the *Trans. Royal Soc. Edin.* vol. iii.: also Faraday's, in Barrow's *Visit to Iceland*). I am unacquainted with their action on the body. It is probably similar to that of the alkaline waters.

Ac'idum Hydrochlo'ricum.—Hydrochlo'ric Acid.

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. It has been known by the various names of *spirit of salt*, *marine acid*, and *muriatic acid*. Some modern chemists term it *chlorohydric* acid. Scheele, in 1774, may be regarded as the first person who entertained a correct notion of the composition of hydrochloric acid. 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.

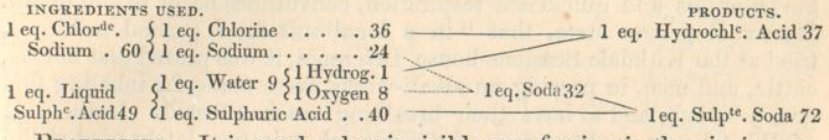
(*a.*) *In the inorganized kingdom.*—Hydrochloric acid is one of the gaseous products of volcanoes. Combined with ammonia, we find it in volcanic regions.

(*b.*) *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 strong liquid sulphuric acid on dried chloride of sodium. The ingredients should be introduced into a tubulated retort, 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, from which the gas expels the air by its greater gravity.

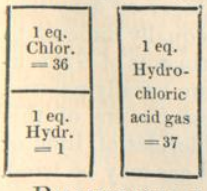
In this process, one equivalent, or 60 parts of chloride of sodium, react on one equivalent, or 49 parts of the protohydrate of sulphuric acid (strong oil of vitriol), and produce one equivalent, or 37 parts of hydrochloric acid (gas), and one equivalent, or 72 parts of the sulphate of soda.



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. 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.

CHARACTERISTICS.—Hydrochloric acid gas is known by its fuming in the air, by its odour, by its reddening moistened litmus paper, and by its forming white fumes with the vapour of ammonia, and by the action of nitrate of silver on an aqueous solution of the gas, 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.



	Eq.	Eq. Wt.	Per Cent.		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	10·000	Hydrochlc. Acid gas	2	1·2847

PHYSIOLOGICAL EFFECTS.—(*a.*) *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 (*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 glass 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 neighbourhood.

(*b.*) *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.

(*c.*) *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 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 the chlorides 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 sulphuric acid over dried common salt, placed in a glass capsule or iron or earthen pot, heated by a charcoal fire.

Antidote.—Inhalations of 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.

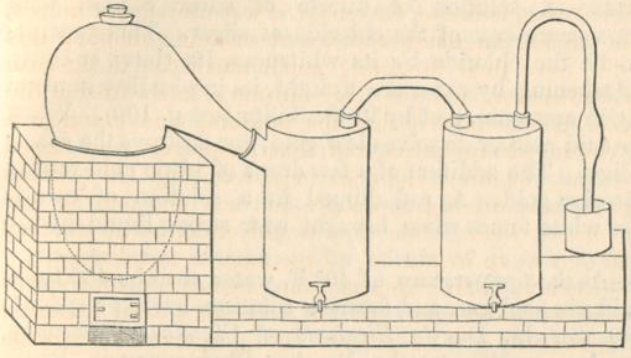
2. *Liquid Hydrochloric Acid.*

SYNONYMES.—This is an aqueous solution of hydrochloric acid, and is usually called, for brevity, *hydrochloric* or *muriatic acid*. It is the *acidum hydrochloricum* of the London Pharmacopœia.

PREPARATION.—(*a.*) *According to the Pharmacopœias.* In the London Pharmacopœia this acid is prepared by adding twenty ounces of sulphuric acid mixed with twelve fluid ounces of distilled water, to two pounds of dried chloride of sodium, placed in a glass retort. Twelve fluid ounces of distilled water are to be put into the receiver Distil by a sand bath. In the Dublin Pharmacopœia a somewhat larger quantity of water is employed. The Edinburgh Pharmacopœia orders equal weights of sulphuric acid, water, and chloride of sodium (previously heated to redness).

(*b.*) *In commerce.*—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 (fig. 40).

Fig. 40.



Apparatus for making Hydrochloric Acid.

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 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 gas dissolves in the water, which, when saturated, constitutes the *common yellow hydrochloric acid of commerce*, which is coloured by iron. By a second distillation, at a low heat, a liquid nearly colourless is obtained, which is sold as *pure* hydrochloric acid.

The *theory* of the above process is precisely that already explained in the manufacture of hydrochloric acid gas. 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 Edinburgh

College order the chloride to be heated to redness, to decompose any nitrate which which may be present; and, in order to insure the complete decomposition of the salt, employ a large excess of sulphuric acid, so that the residual salt is the bisulphate of soda.

PROPERTIES.—Pure liquid hydrochloric acid 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 strength. That of the London Pharmacopœia is 1·16. It is decomposed by some of the metals (as zinc and iron), hydrogen gas being evolved, while a chloride is formed in solution. It is decomposed by those oxyacids which contain five atoms of oxygen—namely, nitric, chloric, iodic, and bromic acids: the oxygen of these acids unites with the hydrogen of the hydrochloric acid to form water. It combines with ammonia, as well as with the vegetable alkalies, to form a class of salts called hydrochlorates or muriates. When it acts on a metallic oxide, water and a chloride are generated.

CHARACTERISTICS.—A solution of nitrate of silver causes, with hydrochloric acid, a precipitate of the chloride of silver. This precipitate is known to be the chloride by its whiteness, its clotty or curdy appearance, its blackening by exposure to light, its insolubility in nitric acid, its solubility in ammonia, and by its fusibility (see p. 105). When pure, hydrochloric acid neither dissolves leaf gold, nor destroys the colour of sulphate of indigo. The addition of a few drops of nitric acid readily enables it to dissolve gold. A rod dipped in a solution of caustic ammonia produces white fumes when brought near strong liquid hydrochloric acid.

COMPOSITION.—At the temperature of 40° F. water absorbs 480 times its bulk of hydrochloric acid gas, and forms a solution, having a specific gravity of 1·2109 (Sir H. Davy's *Elements of Chemical Philosophy*, p. 252). Prepared according to the London Pharmacopœia, liquid hydrochloric acid has a sp. gr. of 1·16, and contains about a third of its weight of hydrochloric acid gas.

Sp. gr. of liquid acid.	Hydrochloric acid gas in 100 of liquid.	Authority.
1·16	32·32	Mr. E. DAVY.
1·162	33·945	Dr. THOMSON.
1·1620	32·621	Dr. URE.
1·1641	33·029	
1·1661	33·437	
1·1681	33·845	

100 grains of liquid hydrochloric acid sp. gr. 1·16 should saturate 132 grains of crystallized carbonate of soda. A better substance for ascertaining the strength of the acid is pure Carrara marble (carbonate of lime): every 50 grains dissolved indicates 37 grains of real hydrochloric acid.

The *Acidum hydrochloricum dilutum* of the London Pharmacopœia is composed of four fluid ounces of the strong liquid hydrochloric acid, and twelve fluid ounces of water. One fluidrachm of it saturates very nearly 32 grains of crystallized carbonate of soda (Phillips, *Translation of the Pharmacopœia*).

IMPURITIES.—The ordinary impurities of the common liquid hydrochloric acid of the shops are perchloride of iron, sometimes a little free chlorine, and occasionally a little sulphuric acid. Dr. T. Thomson

suspects that bromine may be present, partly because this substance has been found in common salt, and partly because a small quantity of this substance gives a yellow colour to pure hydrochloric acid.

The presence of *iron* is shewn 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 produces a purplish colour with a solution of gold.

Sulphuric acid (free or combined) may be detected by adding to the suspected acid a solution of chloride of barium: if sulphuric acid be present, a heavy white precipitate of sulphate of baryta is procured, which is insoluble in both acids and alkalies. 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.

PHYSIOLOGICAL EFFECTS.—(*a.*) *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).

(*b.*) *On living 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.

(*c.*) *On man.*—Properly diluted, and administered *in small but repeated doses*, hydrochloric acid produces the usual effects of a mineral acid before described (pp. 80, 81, and 84): 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 case of poisoning by it (in the human subject) with which I am acquainted, is that mentioned by Orfila (*Toxicolog. Générale*). 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—(*a.*) *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 deposits in the urine. After a copious evacuation, it is, according to Dr. Paris, the most efficacious remedy for preventing the generation of worms; for which purpose the infusion of quassia, stronger than that of the Pharmacopœia, is the best vehicle. It has been employed with benefit in some forms of dyspepsia. Two facts give a remarkable interest to the employment of this acid in dyspeptic complaints; namely, that it is a constituent of the healthy gastric juice; and, secondly, when mixed with mucus, it has a solvent or digestive power in the case of various articles of food, as before mentioned. Lastly, hydrochloric acid has been used in scrofulous and venereal affections, in hepatic disorders, &c.

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

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

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

Order 6.—Nitrogen, and its Compounds with Oxygen and Hydrogen.

Nitroge'nium.—Ni'trogen.

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

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

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

(*b.*) *In the organized kingdom.*—It is a constituent of various vegetable principles, as the organic alkalies, gluten, and indigo blue; and is particularly abundant in the families *Cruciferæ* and *Fungi*. It enters into the composition of most animal substances, as albumen, fibrin, gelatine,