I. *REGNUM INORGANICUM*.—THE INORGANIC KINGDOM.

ORDER I.—OXYGEN AND ITS AQUEOUS SOLUTION.

Oxyge'nium.—Ox'ygen.

HISTORY, SYNONYMES, and ETYMOLOGY.—Oxygen gas was discovered on the 1st of August, 1774, by Dr. Priestley, who denominated it *dephlogisticated air*. In the following year, Scheele also discovered it, without knowing what Priestley had done, and he called it *empyr'eal air*. Condorcet termed it *vital air*. Lavoisier called it *oxygen*, from (ὀξὺς, *acid;* and γεννάω, *to engender* or *produce*.)

NATURAL HISTORY.—(*a*.) *In the inorganized kingdom.*—Oxygen is, of all substances, that which is found in the largest quantity in nature, for it constitutes at least $\frac{3}{4}$ of the known terraqueous globe. Thus, water, which covers about three-fourths of the surface of the earth, contains $\frac{8}{9}$ of its weight of oxygen; and the solid crust of our globe probably consists of at least $\frac{1}{3}$ part, by weight, of this principle; for silica, carbonate of lime, and alumina, the three most abundant constituents of the earth's strata, contain nearly half their weight of oxygen. Mr. De la Beche (*Researches in Theoretical Geology*, p. 8) calculates that silica alone constitutes " forty-five per cent. of the mineral crust of our globe." Of the atmosphere, oxygen constitutes 20 or 21 per cent. by volume, or about 23 per cent. by weight, to which must be added $\frac{8}{9}$, by weight, of the atmospheric aqueous vapour.

(*b*.) *In the organized kingdom.*—Oxygen is an essential constituent of all living bodies. Vegetables, in the sun's rays, absorb carbonic acid decompose it, retain the carbon, and emit the oxygen Hence they have been supposed to be the purifiers of the atmosphere.

PREPARATION.—There are several methods of procuring this gas, but I shall notice three only:—

1. *By heating chlorate of potash in a glass retort.*—This method yields pure oxygen gas. One equivalent, or 124 parts of chlorate of potash, yield six equivalents or 48 parts of oxygen, and one equivalent or 76 parts of chloride of potassium.

SUBSTANCES USED.			RESULTS.
1eq. Chlorate Pot^h. 124	1 eq. Chlo^c. Acid 76	5 eq. Oxy. 40	6 eq. Oxygen 48
		1 eq. Chlo. 36	
	1 eq. Potash . . 48	1 eq. Oxy. 8	
		1 eq. Pot^m. 40	1 eq. Chloride Potas^m. 76

2. *By heating binoxide of manganese in an iron bottle.*—This is the cheapest method, and, for ordinary purposes, it yields oxygen gas sufficiently pure. To free the gas from carbonic acid, wash it with lime-water or with a solution of caustic potash. One pound of the commercial binoxide usually yields from 30 to 40 pints of gas: but, from fine samples, 40 to 50 pints may be procured. Two equivalents or 88 parts of pure binoxide yield one equivalent or 8 parts of oxygen, and two equivalents or 80 parts of the sesquioxide of manganese.

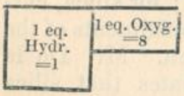
SUBSTANCE USED.	RESULTS.
2 eq. Binoxide Manganese=88	1 eq. Oxygen 8
	2 eq. Sesquioxide Manganese 80

3. *By heating binoxide of manganese with about its own weight of strong sulphuric acid in a glass retort.*—The quantity of acid to be employed should be sufficient to form with the binoxide a mixture having the consistence of cream. This method is followed only when an iron bottle cannot be procured, or when a small quantity of gas is wanted at a very short notice. One equivalent, or 44 parts, of the binoxide, yield one equivalent or 8 parts of oxygen, and one equivalent or 36 parts of the protoxide of manganese: the latter substance forms, with an equivalent or 40 parts of anhydrous sulphuric acid, one equivalent or 76 parts of sulphate of the protoxide of manganese.

SUBSTANCES USED. RESULTS.

1 eq. Binox. Mang. 44 { 1 eq. Oxygen 8 . . . . 1 eq. Oxygen 8
{ 1 eq. Protox. Mang. 36
1 eq. Sulphuric Acid 40 ——————————— 1 eq. Sulph^{te}. Protox. Mang. 76

PROPERTIES.—It is elastic, colourless, odourless, tasteless, incombustible, but a supporter of combustion. According to Dr. Thomson, 100 cubic inches of this gas weigh, at the temperature of 60° Fah., and when the barometer stands at 30 inches, 34·60 grains: hence its specific gravity is 1·11i. According to Berzelius and Dulong, the spec. grav. is 1·1026. Its atomic weight is 8: its atomic volume 0·5, hydrogen being in both cases unity.



CHARACTERISTICS.—If a taper or match be plunged into this gas after the flame has been blown out, but while the wick or charcoal is yet glowing, the flame is instantly reproduced. The only gas likely to be confounded with oxygen in this respect is the protoxide of nitrogen, from which oxygen is distinguished by exploding it with hydrogen. A mixture of one volume oxygen and two volumes hydrogen, yields, by explosion, water only, whereas a mixture of one volume of the protoxide of nitrogen with one volume hydrogen, yields water and one volume of nitrogen.

PHYSIOLOGICAL EFFECTS.—(*a.*) *On vegetables.*—Oxygen gas is essential to the germination of seeds, and to the existence and growth of plants. In the shade vegetables absorb it from the atmosphere, and evolve an equal volume of carbonic acid; while in the solar rays the reverse changes take place; carbonic acid being absorbed and oxygen expired. The vigorous growth of plants in inclosed cases, as originally proposed and practised by my friend Mr. N. B. Ward (*Companion to the Botanical Magazine for May*, 1836), does not invalidate the above statements; since the cases are never completely air-tight, but allow the ingress and egress of air consequent on changes of temperature.

The effects of pure oxygen gas on germination and vegetation have been examined by Theod. de Saussure (*Recherches Chimiques sur la Végétation*, 1804). He found that the period of germination is the same in oxygen gas as in atmospheric air, but that seeds evolve more carbonic acid in the former than in the latter (pp. 11 and 12). Plants do not thrive so well in an atmosphere of oxygen gas in the shade as in one of common air; they give out more carbonic acid, which is always injurious to vegetation in the shade. When exposed in oxygen gas to the direct rays of the sun, they augment in weight about as much as in atmospheric air (p. 93, *op. cit*).

(*b*). *On animals generally.*—It is usually asserted that all animals require the influence of oxygen, or rather of air, to enable them to exist: but this assertion cannot be proved in the case of some of the lower animals. Thus intestinal worms seem to dispense with respiration (Müller's *Physiology*, p. 295). Some animals which respire have no organs specially devoted to this function; in these the cutaneous surface effects respiration; as in the *Polypifera*. In the *Infusoria* the respiratory organs are delicate cilia. Many animals have branchiæ or gills for respiration, as some *Mollusca*, some *Annelida*, and fishes. Leeches respire by subcutaneous sacs which open externally. The respiratory organs of insects are ramifying tracheæ. Lastly, the higher classes of animals respire by means of lungs. Whenever respiration is effected a portion of oxygen disappears, while a quantity of carbonic acid, nearly equal in volume to the oxygen consumed, is produced.

The continued respiration of oxygen gas is injurious, and even fatal to animal life: this has been observed by all experimenters. Animals live longer in a given volume of oxygen than in the same quantity of atmospheric air, but the continued employment of it causes death. Mr. Broughton confined rabbits, guinea-pigs, and sparrows, in glass jars containing oxygen, and inverted over water. At first they suffered no inconvenience, but in about an hour their breathing became hurried, and the circulation accelerated. This state of excitement was followed by one of debility; the respirations became feeble, and were more slowly performed; loss of sensibility and of the power of voluntary motion supervened, till the only remaining visible action was a slight one of the diaphragm, occurring at distant intervals. On opening the body, the blood (both venous and arterial) was found to be of a bright scarlet hue; it was thin, and rapidly coagulated. The gas in which animals had thus been confined till they died, retained its power of rekindling a blown-out taper, and of sustaining, for a time, the life of another animal introduced into it; and Mr. Broughton hence deduced the inference that it does not contain so great an excess of carbonic acid as the gas left when animals have perished by confinement in atmospheric air, and he considered the train of symptoms induced by the respiration of pure oxygen gas as analogous to those which follow the absorption of certain poisons into the system (*Medical Gazette*, vol. iii. p. 775). Injected into the pleura, oxygen gas is very quickly absorbed, without producing inflammation. Cautiously injected into the veins of dogs, it has no sensible effect on the system (*Nysten, Recherches de Physiologie*, p. 60).

(*c*.) *Effects on man.*—If pure oxygen be inspired a few times it does not produce any remarkable phenomena; though some have ascribed various effects to it, such as agreeable lightness in the chest, exhilaration, increased frequency of pulse, a sensation of warmth in the chest, gentle perspiration, and an inflammatory state of system. But several of these results arise probably from mental influence, others from the mode of inhaling the gas, and perhaps some might depend on the employment of impure oxygen.

Uses.—Oxygen gas was formerly employed in medicine in certain diseases supposed to depend on a deficiency of oxygen in the system; and the beneficial results obtained by the use of acids (especially the nitric acid) of the oxides of mercury, chlorate of potash, vegetable food, &c. were referred to the oxygen which these substances contained, and which they were supposed to communicate to the system. These notions are now exploded.

In asphyxia arising from a deficiency of atmospheric air, or from breathing noxious vapours, the inhalation of oxygen gas has been said to be, and probably is, useful. On the same principle, it may be employed during an attack of spasmodic asthma, when there is danger of suffocation, but it is at best only a palliative, and has no power of preventing the occurrence of other attacks. Chaussier has recommended its use in children apparently still-born. To combat the asphyxia of malignant cholera, inhalations of oxygen were tried in Russia, Poland, Prussia, and France, but without success (Merat and De Lens, *Dict. Mat. Méd.* tom. 5me. p. 143).

A'qua Oxyge'nii.—Ox'ygen Water.

At the mean pressure and temperature of the atmosphere, 100 vols. of water dissolve, according to Dalton and Henry (*Elem. Experim. Chem.*) 3·7 vols. of oxygen gas, according to Saussure (*ibid.*) 6·5 vols. By pressure in a proper machine, water may be charged with a much larger quantity (Jourdan, in the *Pharmacopée Universelle*, says with half its volume) of gas. This solution has been termed *oxygenated water*, but is a very different substance to the peroxide of hydrogen, which also has been known by this appellation. It has been used to the extent of one or two bottlefuls daily, as a slight excitant. It is said to increase the appetite and promote the secretions; and to be serviceable in spasm of the stomach, amenorrhœa, hysteria, atonic dropsy, &c.

Order II.—Chlorine and its Aqueous Solution.

Chlorin'ium.—Chlo'rine.

History, synonymes, and etymology.—This gas was discovered by Scheele in 1774, who termed it *dephlogisticated muriatic acid.* Berthollet, in 1785, named it *oxygenated muriatic acid.* Sir H. Davy called it *chlorine* (from χλωρὸς, *green*), on account of its colour.

Natural History.—It is found in both kingdoms of nature. (*a.*) *In the inorganized kingdom* it exists principally in combination with sodium, either dissolved in the water of the ocean or forming deposits of rock salt. Chlorine also occurs native, in combination with magnesium, calcium, lead, silver, &c. Free hydrochloric acid is met with in the neighbourhood of volcanoes, and is probably produced by the decomposition of some chloride. (*b.*) *In the organized kingdom*, it is found in combination, in both animals and vegetables. Sprengel (*Decand. Physiol. Vég.* tom. i. p. 220), says maritime plants exhale chlorine, principally during the night. Hydrochloric acid, in the free state, exists, according to Dr. Prout, in the stomach of animals during the process of digestion.

Preparation.—There are several methods of procuring chlorine gas :—

1. *By adding sulphuric acid to a mixture of common salt and binoxide of manganese.*—This is the cheapest and most usual method of preparing it. Mix intimately three parts of dried common salt with one part of the binoxide of manganese, and introduce the mixture into a retort. Then add as much sulphuric acid, previously mixed with its own weight of water, as will form a mixture of the consistence of cream. On the