Notes of

C/C

Lectures

on

Chemistry

delivered at

the

Montreal Pharmaceutical

College

Tuesday October 2nd 1877

Lecture 1

All things are materials
That which moves or alters them is force

There are three masses
1st Simple all particles the same as Iron
2nd Mixed A lump of different particles compressed together
3rd Chemical; one in which the various particles are so united that analysis is necessary to divide them.
Atoms are the ultimate particles of matter and are

Thursday Oct 4th 1877.

Lecture 2.

Affinity is the disposition between different bodies which causes them to

combine in definite quantities

Synthesis is a combination of two elements.

Analysis is the seperation of combined bodies.

Combustion is chemical action combined a accompanied with light & heat

Organic substances when burnt show a surplus age of carbon. (SO_4)

Exp 1 Sugar (CH_2O) with Sulphuric Acid added takes the water (H_2O) which joins the Acid leaving the carbon (C).

Exp 2 Sodium placed in water combines with the ~~oxy~~ oxygen in the water; hydrogen being freed.

Exp 3. The Decomposition of Zinc in water by Sulphuric Acid; setting free the hydrogen.

Tuesday Oct 9th 1877

Lecture 3.

Elements are divided into two classes
Metallic and Nonmetallic
The nonmetallic produce nearly all the
non acid oxides as

Carbon + Oxygen (C+O) = Carbonic Acid
" + " 2 atoms ($C+O_2$) = " Anhydrid
$H_2 + O$ = Water (H_2O)

Composition 100 lbs Air.

Oxygen	20.6
Nitrogen	77.9
Carbonic Dioxide	0.04
Aqueous Vapour	1.4
Ammonia.	Traces.

Thursday Oct 11th 1877

Lecture 4.

Oxygen . O. . 16.

Discovered in 1774 by. Priestly & Scheele

It is a colourless odourless & tasteless gas

And is a supporter of combustion having

also a powerful affinity for other bodies

Fluorine being the only element of which

no oxide is known; nearly all bodies

owe their acidity to it.

Its Specific gravity is 1.105, 100 cubic

inches weigh 34 Grains and a litre 1.435

It can be obtained from

Hydrarg. Oxe. Rub by heating

Potass~~s~~ Chlor " "

Mangan Binoxide " " also from

Red lead: the Nitrates of Potass &

Soda: Bleaching powder: Also by

passing a current of air over the

Hydrate of Baryta heated

A cheap manner of obtaining it in

large quantities is by mixing

Chlorate of Potass & Peroxide of Manganese; but care must be taken that the materials are pure because there is danger of an explosion. Chemical Sulphur burnt in oxygen produces Sulphurous Acid (SO_2) Exp 4

Charcoal " " " " Carbonic Acid in the form of Gas (CO_2) Exp 5

Exp 6 The presence of the Carbonic Acid is produced by putting lime water in the vessel in which combustion took place; a white milky liquid is made

Metals Oils Leaves and fine Powders all undergo oxidyzation by exposure

Acides are of three classes as

Boric	Manganese Acids
Nitric	Water
Acid	Phosphoric Acid

The more oxygen present the more acid as

CHO_2 = Formic Acid

$C_2H_2O_2$ = Acetic "

$C_5H_{10}O_5$ Valerianic "

(4th Lect) 11/10/77

The Oxide of Nitrogen (NO) has the power also of supporting combustion.
Nitrate of Oxygen is more soluble in water than the gas.
To test a mixture. Pyrogallic Acid and Potash turn it black
Oxide of Nitrogen & Oxygen endues red fumes

Tuesday Oct 16th 1877

Lecture 5

Combustion of Carbon in Oxygen in a closed vessel produces Carbonic Acid
Laws of Chemical Combination
Law I. All Chemicals are definite in their nature the ratio of their elements being constant
" II When a body is capable of combining with a second in ratio of proportion the proportions bear a simple relation

to each other

Law III If a body A unite with others B C. D. the quantities of the latter which unite with A, represent the relation in which they unite among themselves in case of a union taking place..

" IV The combining quantity of a compound is the sum of the combining quantities of its elements.

Example The Result of the combustion of two substances containing Carbon & Hydrogen produces water (H_2O) = 18 Carbon burnt in plenty of Oxygen = (CO_2) Carbonic acid; in little Carbonic oxide (CO) ($CO = 28$) ($CO_2 = 44$)

Ex of IV Carbonic Acid = 44

Oxide of Lime (CaO) = 56

100

{C = 12
O_2 = 32}
{Ca = 40
O = 16}
100

Soda Carb and acid Hydrochlo produce Carbonic Dioxide & leave Chloride of Sodium

The result of combining acid Nitr with Carbonate of lead gives

similar results.
Carbonic Acid is produced from the lungs
CO_2 is capable of combining in two proportions.

Thursday Oct 18th 1877.

Lecture 6th

Non Metallic Elements

Hydrogen H 1. is taken as the unit of the atomic weights as it is most capable of combining with the other elements in the smallest proportions

Hydrogen generally combines with Oxygen as H_2O (water) but sometimes H_2O_2 a peroxide of hydrogen found in solution as ozone water.

Carbon (C, 12) is found in different forms resulting from the different decompositions of different substances

It is polymorphic possesing three conditions 1st Graphite 2nd Cryptalline 3rd Pulverulent.

It is largely obtained by roasting wood in closed vessels.

Charcoal burnt freely produces CO_2 Carbonic Dioxide leaving wood ashes from which potash is obtained

Plumbago and the Diamond are the results of imperfect combustion of substances containing Carbon.

Soot another form of Carbon does not possess the power of deshoying the colour of vegetable solutions as is possesed Animal Charcoal

Boron & Silicon these ~~posses~~ possess many qualities similar to Carbon viz They are all combustible in oxygen and polymorphic, having the

6th Lect 18/10/77

same forms as the first, are non conductors, form alkaline bases & salts and insoluble and hard minerals and Earthy slages of a vitreous nature

Boron. (B .11)

is seldom seen it forms compounds with Hydrogen & Oxygen, and is always found accompanied with present or past volcanic action

Boracic Acid ($BoAs_3$) is obtained by a natural process and is produced in Tuscany Thibet or South America either pure or as a Bi borate of Soda or Lime.

When combined with Sodium it forms the Borate ($Na_2B_2O_3$)

Solution Boracic Acid forms a green flame when added to fire

Borax yellows a flame

When burnt both Borax and Boracic Acid turn to a vitreous substance which is coloured by others.

Tuesday Oct 25th 1877

Lecture 7th

Silicon Si 28 Density 2.49

Silicon is a tetratomic element

It does not exist uncombined but it is the principle element in the stony part of the Globe.

It forms an amorphic powder of a dull brown colour burns when heated in air

In its graphik state it contracts when heated making hexagonal scales, it also marks like plumbago

Crystalline as quartz

With oxygen it forms a Deoxide Silicic Acid SiO_2

Glass is composed of silicates if not annealed the slightest fracture ruins the whole lump.

It also forms the stiffening of the plants in the veget. kingdom especially in the Algae and—

4th Lect 23/10/17

Silicon

Gramineae

It is also found in the animal king dom.

Flint glass is made from the Potassic Silicates and the Oxide of Lead it is more fusible than the others

Crown Glass contains no lead compound; but the Silicates of Lime Alumina & Sodium

Thursday October 25th 1877

Exp. By heating with water Sulphate of Ammonia and Slaked lime an alkaline reaction takes place; Ammonia being given off the the others combine.

The four great non metallic elements which form the whole organic kingdom are Hydrogen Nitrogen Oxygen + Carbon Nitrogen (N. 14) combines in various ways.

" combines with Hydrogen as NH_3 NH_4

NH_3 is Anhydric Ammonia NH_4 Ammonium

It combine with oxygen in the following.

N_2O is Nitrous Oxide

N_2O_2 " Nitric "

N_2O_3 " " Sesquioxide

N_2O_4

N_2O_6

Nitrate of Ammonia NH_4NO_3 when heated gives off water H_2O and Nitrous Oxide N_2O by combination = $2H_2O + N_2O$.

$NH_4 = \left\{ \begin{matrix} N \\ H \\ H_2 \end{matrix} \right.$

$NO_3 = \left\{ \begin{matrix} N \\ O_2 \\ O \end{matrix} \right.$

8th Lect 25/10/77

Nitrite of Ammonia may be formed by heating a piece of platinum wire red hot and placing it in Ammonia fumes in a close vessel, the elements of the ammonia combining ~~separately~~ with the oxygen.

Tuesday November 6th 1877

9th Lecture

The Sulphur group is composed of Sulphur (S. 32) Selenium (Se 79.5) & Tellurium (Te 129) They all combine & Hydrogen forming offensive & foetid gases.

Oxygen may be classed in this group but it stands rather apart.

Phosphorus & Nitrogen both form Acid compounds with Oxygen and gases with Hydrogen as NH_3 & PH_3

Chlorine Iodine Bromine & Fluorine form acid gases with both Hydrogen & Oxygen.

Thursday November 8th 1877

10th Lecture.

Sulphur. S. 32.

is largely diffused in nature united with Hydrogen or Oxygen nearly always found near present or past volcanic action. It is polymorphic soluble in alkalies & has a great affinity for oxygen. When rubbed with Potass Chlor it forms a detonating mixture. When burnt in air produces Sulphurous Acid gas which is soluble in water and is possessed of bleaching powers. Soluble in alcohol ether oils and Carbon Bisulph. Water absorbs 50 volumes but can take more by pressure Sulphuric Acid H_2SO_4 is manufactured from the Sulphuric Anhydride by the aid of Nitrate of Potassium.

11th Tuesday Oct. 20th 1877

11th Lecture.

The Marine Group

This Group consists of Chlorine, a green gas, Symbol Cl Atomic Weight 35.5 Density 2.5.

Bromine an orange liquid Bx. 80. In vapour its density is 5.41 in liquid 2.98

Iodine is a blue-black crystalline solid with a ~~met~~ metallic lustre Sym. I. 127 Density of vapour 8.78 of liquid 4.947.

These are all bleaching bodies on account of their affinity for hydrogen. They also form acids with both oxygen & hydrogen, these acids however do not possess bleaching powers. If the Hydrogen be replaced by a base a neutral salt is formed.

Chlorine formerly called oxymu-

-ratic acid may be condensed into a liquid by cold or pressure

Bromine was first obtained from mineral springs but it and Iodine are now obtained from seaweed

Iodine forms a blue colour with starch Bromine an orange

This Group combines easily but they will readily decompose

Iodine combines with ammonia forming an iodide of nitrogen; it is also combines with phosphorus by merely being placed in contact, combustion takes place and a red oxide of Phosphorus is generally left

Phosphorus may be burned under water by placing it in a vessel with Potas. Chlor. and pouring ~~it~~ on the Pot. Chlor a little Sulphuric Acid on a tube, an oxide of chlorine called uchlorine is formed which when placed on the phosphorus causes it to burn.

Tuesday Nov. 27th 1877
Lect. 12th

Phosphorus P 31. is a pale yellow sol-
-id something resembling ~~beeswax~~
beeswax. It is produced from
bones burnt to whiteness and heat-
-ed with dilute Sulphuric Acid
Superphosphate Lime is obtained. By
the addition of Carbon and by dis-
-tillation the phosphorus is obtained
Another condition of Phosphorus called
the Amorphous is obtained by heating
Phosphorus to about 500°
Phosphorus combines with oxygen
as Phosphoric Anhydride P_2O_5 and
Phosphorous Anhydride P_2O_3.
It also combines with Hydrogen
in several proportions but not as
~~as~~ bases Phosphuretted Hydrogen
may be obtained by heating together
Potash Phosphate of Lime and Ether
in a retort and allowing the gas

bubles to pass through water and on contact with the air they burst into flame.
Phasphorus is highly inflammable and if burnt on a carbon substance it renders it almost unburnable owing to the phosphoric acid formed. When burnt in air it forms white fumes soluble in water making Phosphoric acid
It is soluble in oils and ether

Tuesday Dec 4th 1877
Lect 13th
Metallic Elements
There are forty nine elements in this class. These generally produce Basic Oxides. They are opaque and conduct heat and electricity, reflect light and are electropositive. They are usually found as oxides Carbonates or Silicates or with Sulphur

13th Lect 4/12/77

as pyrites a few are sometimes found in a natural state; they nearly all form soluble salts with the mariner group

Potassium K. 39. Density 0.865

This metal occurs abundantly in nature but only in combination. It is obtained from the ashes of plants and from rocks in Germany. It can be obtained by heating cream Tartar. It is white in colour with a blue tinge and readily oxidizes. taking fire when place with either water a ice

Thursday Dec 13th 1877

14th Lecture

Calcium, Barium, Strontium

A decreasing solubility of the Sulphates may be marked from Sodium Sulphate to Barium Sulphate.

Calcium Ca . 40. Density 1.57 It is largely found as a carbonate though it it frequently occurs combined with acids. The metal is seldom seen owing to its difficulty of preservation

Oxide of Calcium (CaO) or Quicklime is obtained from Calcium Carbonate by heat as $CaCO_3 = CaO + CO_2$

This oxide is not more soluble in hot than in cold water

Calcium Carb is largely used; the most common form is Whiting and the next coarsest the Creta Preparata Creta Precipitata is made by heating lime & Hydrochloric Acid and precipitating with Sodae Carbonas

13/12/77
4th Lect.

Sulphate Lime is in its most common state known as Plaster of Paris. It is only soluble 1 part in 460. A Solution of this salt causes a precipitate with with Solutions containing Barium Strontium a Lead
Phosphates of these several are known the most important being the lone-earth or bibasic phosphate, If Acid Sulphuric be added to remove 2/3 of the Lime the Superphosphate is left.
Another Salt is the Calcic Chloride $CaCl_2$ a Chl of Lime
Lime exhibits strong affinities for Soap and Carbonic Acid.
Caustic Lime takes all the Acid from the Carbonates of the first group of metals. When combined with Acid Carbonic it is not alkaline

14th Lect

Barium Ba 137 occurs as a Carbonate in the substance called Witherite
Its oxide does not absorb Carbonic acid as Lime does. A higher or peroxide of Barium is also known. It is poisonous and has been used as a vermin killer
Strontium Sr 87.5 Density 2.54.
This is also found as a carbonate. Its oxide is made from the nitrate
Strontium Chloride is Crystalline and soluble in water and Alcohol
Lime burns with an orange red flame
Barium " " a green "
Strontium " " " red "

15 Lect.

Tuesday Dec 15th 74

Zinc Zn 65.5

This metal is found either as a Sulphide (Blende) or a Carbonate (Calamine) Calamine is seldom pure being associated Arsenic, Zinc ores are seldom pure mostly containing Iron Antimony &c It readily alloys with mercury and forms a compound which does not dissolve in dilute Acid Sulphuric and is as useful for batteries as the pure metal.

Zinc is prepared from Calamine by heating the mineral with Coke till it slightly volatilizes and passing it into water.

Calamine is often mixed with Baryta Carb. Zinc Sulphate and Carbonated Potash form a precipitate of the Carbonate & Hydrated Oxide of Zinc which is generally impure on account of Acid Salts formed.

Zinc heated forms an Oxide, it has however less affinity for Oxygen than Magnesium has.

The Sulphate resembles that Magnesium so closely that the eye fails to distinguish them

Its Chloride has been introduced as a disinfectant, but many deaths from mistakes have occured.

Its chlorides and Oxides are soluble A Solution of Oxide Zinc is precipitated by Ammonia and then redissolved With Hydrosulphuric no precipitate Ammonia added Zinc Sulphuret is formed. If the metal is heated & Sol Cobalt green is formed Its Iodides are used in Photography

Cadmium Cd 112 is laisely associated & Zinc but is more volatile fusing at 315° and destilling at 450° Cent. It is precipitated from solution by Sulphuretted Hydrogen. Its Iodides & Bromides are used by photographers.

Tuesday. Jany 8. 1878.

16 Lecture

The Elements are divided into two groups the Metallic & Nonmetallic Hydrogen is classed among the metals They may also be divided into Alkaline Metals Those forming Alkaline Earths " " Earths Rusting Metals Those forming Acid Oxides " " doubly Basic " noble Metals They are also grouped in relation to atomicity Monatomic Elements as Lithium Ammonium Sodium Potassium argentum Diatomic Calcium Strontium Barium - Magnesium Zinc Cadmium Copper Mercury and Lead

16th Lect

Tri atomic Aluminium Chromium
Iron Cobalt Nickle Manganese these
form proto and Sesqui Salts
Also Uranium Venadium Gold Thallium
Molybdenum and Tungsten - Tin and
Titanium
Tetratomic as Palladium Rubidium
Osmium Iridium Platinum &c
Pentatomic as Arsenic Antimony &
Bismuth
Phosphates of the first are soluble
salts. Calcium and Magnesium Phos-
phates are soluble in Acid solutions
but are thrown out by Ammonia.

Thursday Jany 10th/78
17th Lecture

Copper Cu 65

Found as Silicate and Carbonate also in the shape of pyrites frequently accompanied by Arsenic. These roasted are used for Acid Sulphuric the remainder and Cupric Oxide is used for extracting metallic Copper

Copper also forms a Suboxide

To a solution of Cupric Sulphate add an Alkali also Glucose and then Boil Cu_2O is thrown down

A similar solution with an alkali throws down verdite By boiling an oxide is formed

Its Nitrate heated forms a black Oxide

Ferrocyanide of Potash forms a fawn colour with it

With Iodide of Potassium CuI_2

Paris Green is also an arsenious salt of this metal

Tuesday Dany 15th 1877

1st Lect.

Mercury. Hg 200. Lp. G. 13.6.

This is a well known metal and has been in use for many years being known to the ancients

It is ~~light~~ silver coloured very fluid extremely mobile and one of the heavier metals

It boils at 660° far. or 330° Cent and Solidifies at 39° below.

It is found native or as Cinnabar a Sulphide of a red brown colour used largely as medecine and in various manufactures; also in the battery.

Thursday. 17th Early 4/7
19 Lect.

Mercury does not readily oxidize but is susceptible to Sulphur Heated it turns to the Anhydrous red oxide HgO.
With Subsalts of mercury and an alkali a Suboxide is precipitated $Hg_2O(H_2O)$.
With a persalt a yellow precipitate is formed which is also an Oxide
Mercury forms a double series of salts
With dilute Nitric Acid a solution of ~~dilute~~ Mercuric Nitrate $HgNO_2$ is obtained. It also shows a disposition to form Persalts.
Its Chlorides may be prepared from Salt and mercurous Sulphate.
Ammonia added to the Chloride Solution forms the White Precipitate Hyd Ammon Chlor.

Mercuric Chloride ($HgCl_2$) + Iodide of Potassium 2 K I. forms the Beniodide HgI_2 a reddish powder heated it turns yellow when rubbed regains its red

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Lead Pb. Weight 207 Density 11.45

Lead has been known for many years being mentioned in Scriptures and ancient authors.

The principle ore is its Sulphide called Galena found in England & Spain. It is crushed and washed and partially roasted. The air being cut off and the heat raised burns it into the metal and into Sulphurous anhydride. Lead is malleable though not ductile. It melts at 330° and also when strongly heated vaporizes. It is largely used for domestic and other purposes and it is frequently alloyed to make it harder. It oxidizes in air or water

if the water is free from saline matters
It forms several oxides the common oxides are
Lythargo which is of a pale buff colour and
is used in the preparation of lead plaster
Red Oxide Pb_3O_4 used as a pigment
and the peroxide PbO_2. Another salt much
used is the carbonate $PbCO_3$ sometimes
found pure; it is used as a pigment
Plumbic Nitrate $Pb(NO_3)_2$. Plumbic
Acetate $Pb(C_2H_3O_2)_2$ or Sugar of
Lead is prepared by dissolving lithargo
in Vinegar. It is used in various
preparations of the Pharmacopeia
Lead Salts are poisonous.
Tests Sulphuric Acid gives a very
insoluble precipitate of the Sul-
phate of Lead
Potass Chrom produces a yellow
precipate with a solutions of Lead
Salts.

Triatomic Group

These metals are Aluminium Chromium Iron Cobalt Nickel and Manganese They form Sesquioxides so called because for every equivalent metal there is 1½ of Oxygen The combine with Chlorine 1 to 3.

Aluminium at Weight 27.5 Density 2.6 This is a rather abundant element chiefly associated with oxygen or Silicon. It is a bluish white metal malleable and ductile and does not tarnish and scarcely oxidizes Its chief salts are its Sulphate $Al_2(SO_4)_3$ and its combination as common alum or Sulphate of Aluminium and Potassium $Al(KSO_4)_2 12H_2O$ It forms large regular Xtals. Its is astringent and also acrid and is largely used in dyeing and in medicine

Chromium Cr 52.5 Density 6.7

This metal is noted for the beauty of its various compounds. Its name is from the Greek χρωμα Colour. It forms a long series of combinations with oxygen Its compounds are obtained from chromic iron ore $FeO + Cr_2O_3$. As a metal Chromium is little known. Chromic Anhydride (CrO_3) or Chromic acid is the highest Acide made by mixing a solution of Dichromate of Potassium with strong Sulphuric Acid. The acide is thrown down in beautiful crimson needles. If placed in water it forms ~~Chromic~~ hydric Chromate This ~~salt~~ is the type of a series of salts called Chromates such as Potass. Chromas. K_2CrO_4 a yellow crystalline salt Potass. Bichromas. red crystals

Tuesday. Feb 5th 1878

Ferrum Fe 56 Density 7.8

Iron is found in great abundance and is probably the most useful metal of all It has been long known being mentioned in Genesis. It is sometimes found native and is frequently obtained very pure in the meteoric bodies It is also obtained as the black oxide Fe_3O_4 abundant in Sweden and north America and is called magnetic Iron ore contains about 72 per cent of Iron
The haematite or Red oxide Fe_2O_3 in Cumberland & Germany. Its Carbonate $FeCO_3$ and its Sulphide FeS_2 or pyrites which are frequently associated with Arsenic. Iron is purified by smelting.
Iron is diatomic forming a protoxide and its salts are double the ferrous or ferric.

Tuesday Feb 8th 1876

Ferrous Carbonate $FeCO_3$

Sulphate $FeSO_4$ or green vitriol of commerce light green crystals slowly oxidizing if exposed. This is used in the arts and in the manufacture of black ink.

The tests for ferrous salts are

Potass Prussias flav. gives a blue white precipitate rapidly changing to dark blue

Red Prussiate gives a deep blue at once

Sulphide of Ammonia gives a black precipitate

Thursday February 14th 1876

Pentatomic Group.

Bismuth Arsenic Antimony

Bismuth alloyed with other metals reduces the melting points

Antimony possesses the same quality

Bismuth forms a pentachloride with HCl. $BiCl_5$. When a solution of either a Chloride or Nitrate is poured in water an acid salt is

precipitated while a basic salt remains in solution

Chloride of Antimony also acts in the same manner

Arsenic is found associated with many ores

Notes Chemistry

Nonmetallic Elements

Gaseous Hydrogen Oxygen Nitrogen
Fluorine Chlorine

Liquid Bromine

Solid. Iodine Boron Silicon Sulphur
Selenium Tellurium Carbon
Phosphorus

Oxygen O. 16 Sp.G. 1.1056

It is a colourless tasteless inodorous gas, soluble in water to the extent of 3 volumes in one hundred

It is the most abundant element known 8/9 of water and about 1/3 of the air being oxgen

It was discovered by Priestly in 1774 and Scheele 1775

Most oxides yield it by heat

Red Oxide of Mercury being about the best

Di
Mangan. Axide with heat also gives
large quantities off
$3MnO_2 + Heat = Mn_3O_4 + O_2$
Chlorate Potass heated also gives Oxygen
$2KClO_3 + Heat = 2KCl + 3O_2$
Chlorate of Potass and the Binoxide of Manganese yeild it better together care being
taken that they are pure
a Clear solution of Chloride of Lime (B.P)
with Peroxide of Cobalt also yeilds gas
Potass Bichrom + Acid Sulph
$K_2Cr_2O_7 + 4H_2SO_4 = \{2KCr(SO_4)_2\} + 4H_2O + O_3$
also
$H_2O_2 + Ag_2O_2 = H_2O + Ag_2 + O_2$
Oxgen supports combustion and forms
compounds with all elements but
fluorine
an Alkaline solution of Pyrogallic
acid turns Black with oxygen

Ozone this is by some said to be the negative atom of Oxygen Gas and that the positive has yet to be isolated
It can be obtained by adding Powd Oxalic Acid to a Sol^{n} of Potass. Permang
It is an oxidizing agent and bleaches vegetable colours
Oxygen forms many oxides with different metals and with some it forms a long list as

MnO	Protoxide Manganese
Mn_3O_4	(3/4) Oxide "
Mn_2O_3	Sesquioxide "
MnO_2	Peroxide "
H_2MnO_4	Manganic acid
$HMnO_4$	Per — "

Nitrogen

N 14 Sp.G. .9713

This element was discovered by Rutherford in 1772 and it is peculiar from the difficulty of making it combine or stay in combination with other elements Lavoisier called it Azote because of its action on life. It extinguishes both life and fire

It can be obtained from

Nitrite of Ammonia

$NH_4NO_2 + heat = N_2 + 2H_2O$

or Muriate of Ammonia & Nitrite of Potash

$NH_4Cl + KNO_2 = 2H_2O + KCl + 2N$

It is colourless tasteless and odourless and it is soluble to 1/50 of its bulk in water

air contains by vol O 20.81 N 79.91

" " " weight O 23.01 N 76.99

100 cubic inches Air = 31.074 lbs

1 " foot " = 536.95 "

Air contains

O	20.61
N	77.95
CO_2	.04
Aq. Vapour	1.40
NH_3 Carb. Hyd	Sulphurous Gas } Traces.
HNO_3 Sulph. "	

Hydrogen

H . 1. Sp.G. .0692

First noticed by Paracelsus in 1600 but discovered and named by Cavendish in 1766 as Inflammable air.

Made be made by passing steam over hot iron turnings or by Zinc and solution of Potash

$Zn + 2KHO = K_2O, ZnO + H_2$

It may also be obtained from Zinc Water and Sulphuric Acid.

It is colourless tasteless odourless and inflames readily

It is the lightest and most refractive gas.

100 c.c. (grammes) water take up 1.93 Hydrogen

It passesses the property of raising the tone of the voice

Carbon C .12

Carbon is an amorphous substance and is largely distributed

Diamond is about the purest natural state. They are very hard and belong to the cubic system of crystals Their Spec Grav is about 3.3. Found chiefly in ~~o~~ alluvial deposits They also contain a little Silica & Peroxide of Iron

Graphite or Plumbago Sp.Gy. 2.2 is the source of the lead pencil is also a form of carbon. Found in Cumberland United States, Ceylon Canada

Coal is a less pure state than ~~coal~~ Graphite containing Hydrogen Oxygen Iron Sulphur Nitrogen and earthy salts Coal heated gives off gas and leaves a substance Coke

Charcoal can be obtained from the burning of oil or by slowly charring wood without air.

Charcoal

Carbon possesses great powers for absorbing gases consequently it makes a good disinfectant

It also discolours solutions filtered through even removing to a great extent all organic matter in them Charcoal from blood is the best for decolorizing

Carbon also deoxidyes changing Mercuric or Ferric Salts into Mercurous or Ferrous. It combines directly with Oxygen Hydrogen & Sulphur

Carbonic Gas CO_2 44 Sp.G 1.529 called Carbonic Anhydride or Carbon Di oxide is a colourless gas with an acid taste and smell noninflammable and does not support combustion 100 cubic inches weigh 47.403 grs It liquefies at 32° Fah under the pressure of 32 or 34 Atmospheres Water dissolves its own bulk It can be prepared from any car-

bonate by means of an acid as

$CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$

Carbonates except the alkaline ones are insoluble in water

Carbonic Gas added to water assists in the solution of many. Carbonates yeild up gas when heated with a mineral acid leaving salts of that acid

Limewater or a Subacetate of Lead solution grow milky if CO_2 is passed through them

The acid radicle is bi-basic forming Carbonates and Bicarbonates as

Na_2CO_3 Carbonate Soda

$HNaCO_3$ Bi " " "

Carbonates also combine forming double carbonates

Carbonic Acid Oxide

CO - 28

Discovered by Priestly about 1690 but was not much understood till examined later by Woodhouse

Charcoal heated with Peroxide of Iron yields it. Carbonic Acid Gas passed over red hot Iron also gives the oxide as $CO_2 + Fe = CO + FeO$

Ferrocyanide of Potassium and Acid Sulphuric heated gently with a little water also yield the gas

$K_4 Fe C_6 N_6 + 6 H_2 SO_4 + 3 H_2 O$
$= 6CO + 2K_2 SO_4 + FeSO_4 + 3(NH)_2 SO_4$

Also from Formic Acid

$C H_2 O_2 = CO + H_2 O$

Colourless transparent Neutral & vegetable colours Water dissolves 1/40 of its own bulk; burns with a blue flame

One volume contains half a molecule of Oxygen.

Carbonic Oxide unites with Chlorine as $COCl_2$ or Phosgene gas

Carbon will not unite directly with Chlorine but can be made to by substitution as Marsh gas CH_4, the H_4 may be replaced by Cl_4 forming CCl_4 Tetrachloride Carbon

Carbon combines with Sulphur as a bisulphide CS_2 Heat Charcoal to a red heat in a vessel with a long spout and then drop in Sulphur the Bisulphide drops through

Its Sp.G. is 1.293 Burns readily boils at 46° Fah Dissolves Sulphur Iodine & Phosphorus.

Nitric Acid

Monohydrated HNO_3 1.517 first examined by Cavendish

Electric Sparks through moist air & hydrogen yield Nitric Acid

Nitrate of Potash (or Soda) and Sulphuric Acid as $KNO_3 + H_2SO_4 = HNO_3 + KHSO_4$ or

$2KNO_3 + H_2SO_4 = 2HNO_3 + K_2SO_4$

The Pharmacopeia Acid contains about 60 pc of the anhydrous acid N_2O_5. Anhydrous may be obtained from Nitrate of Silver and Chlorine by heat to yeild N_2O_5 but the ~~$AgNO_3$~~ decomposition is not known It is a silky crystalline substance the dry Xtals are not corrosive Diluted nitric acid is best for metals as a solvent.

Impurities are Sulphuric acid a Solution of Barium Chloride will at once precipitate H_2SO_4 from the Nitric Acid

Muriatic Acid this is precipitated by ~~Chloride~~ Nitrate of Silver as Chloride

For Ison or Potassium evaporate to dryness

Nitric Acid is monobasic

It is not precipitated by anything as its salts are soluble

Nitric Acid in solution may

be detected by putting a crystal of Sulphate of Iron in the liquid and carfully adding Acid Sulph. A dark cloud is formed as $6FeSO_4 + 2HNO_3 + 3H_2SO_4 = 3(Fe_2,3SO_4) + 2NO + 4H_2O$
or heat the Acid with copper and red fumes are given off
Brucia reddens with Nitric Acid

Nitrous Oxide Laughing Gas
N_2O 44 Spg 1.527
Nitrate of Ammonia + heat = N_2O
as $H_4N,NO_3 = N_2O + 2H_2O$
transparent colourless & sweetish
Soluble to the extent of 130 pts to 100 of Water. Used as an anesthetic.
Relights a smouldering match.
Is easily respirable.

Nitric Oxide

NO = ✱ 30

Prepared from Copper and Nitric Acid

$3Cu + 8HNO_3 = 3Cu2NO_3 + 2NO + 4H_2O$

A neutral colourless gas with a disagreeable taste reddening with oxygen

Water dissolves one thirtieth of its bulk

Nitrous Anhydride

N_2O_3 = 76 Hyponitrous Acid

Prepared from 1 part Starch and 8 pts Acid Nitric 1·25 heated together. Passed over Chloride of Calcium fused, at Zero Fahr it turns into a blue liquid

Dissolved in Water it forms Nitrous Acid HNO_2. It destroys the colour of Indigo and Potass Permang.

Changes Potass Bichrom to the green Chromium Salts

Starch Iodide of Potassium and a little Hydrochloric acid give a blue colour with it or with nitrites

Peroxide of Nitrogen

$NO_2 = 46$

Can be condensed into a liquid boiling at 71° Fahr

Nitrate of Lead + heat yield this gas

$2(PbO_2NO_3) + heat = 2PbO + 4NO_2 + O_2$

a suffocating gas, supporting combustion Potassium inflames spontaneously if placed in it

Forms a red transient colour with Sulphocyanide of Potassium.

Ammonia gas

$NH_3 = 17$ Sp. G. .59

Gaseous Ammonia and its salts are formed from the gas liquor from coal distilling. Caustic or Slaked Lime and Sal Ammoniac will yield gas if mixed, equal parts are best.

$CaO + 2NH_4Cl = CaCl_2 + 2NH_3 + H_2O$

1/3 Sal Ammoniac yields 380 cubic inches gas. It is colourless with a pungent odour and is fatal to life

if rejoined. It does not support combustion but if heated burns with a pale green flame. Soluble in water at 32 Fahr to the extent 1050 times the volume of the water. Condenses at -103° Fahr to a solid and to a liquid at -40°. Has a strong alkaline reaction and neutralyzes strong acids. Solution of Ammonia freezes at -40° into a non odourous gelatinous mass No residue should be left by the evaporation of this solution. If lime is suspected add an oxalate and heat to a carbonate and if it effervesces lime with an acid lime is present. A compound body

Ammonicum

is believed by many to exist from which it is said the salts are made. As the salts are isomorphous with the Potassium and Sodium salts and the

same alkaline reaction is found in the three classes it is supposed that the body exists

Further the salts have the same composition as regards the quantity of acid in the different ones as

Hydrate of Ammonia $NH_3^{H_2O}$ may be written NH_4HO Potassium Hydrate KHO

Hydrate of Ammonia NH_3H_2O or $(NH_4)HO$ = $(K)HO$ (Potass)

Chloride " " NH_3HCl or $(NH_4)Cl$ = $(K)Cl$

Acid Sulphate " $2NH_3H_2SO_4$ or $(NH_4)HSO_4$ = $(K)HSO_4$

An Amalgam of Sodium and Mercury placed in a solution of salammoniac swells many times its own bulk.

Chlorine

Cl 35.5 Sp.G. 2.47

This element with Iodine Bromine and Fluorine form a group called halogens; they are never found free. Chlorine was discovered by Scheele in 1774. It is a transparent greenish gas with a suffocating taste and smell. 100 cubic inches weigh about 77 grains. It liquefies under 4 atmospheres at about 60° Fah to a liquid 1.33. It is soluble in water to half its bulk. Not combustible nor is it a supporter of combustion Phosphorus and several other elements burn spontaneously in it. Spts Turpentine does so also. It occours largely combined with Sodium. Chlorine is a bleaching agent, removing the Hydrogen from bodies by com-

-bination and replacing it
Salt Sulphuric Acid and Mangan
-ic Binoxide heated produce it

$$MnO_2 + 2NaCl + 3H_2SO_4 = MnSO_4 + 2NaHSO_4 + 2H_2O + Cl_2$$

Chlorine combines with all metals
the chlorides are soluble with few
exceptions. As a rule there is a
chloride for every basic oxide. Free
chlorine dissolves gold leaf

Hydrochloric Acid Gas

HCl 36.5 Sp.G. 1.24

Solutions of Chlorine gas turn to the
acid if kept. This acid may be made
from Salt and Sulphuric acid

$$NaCl + H_2SO_4 = NaHSO_4 + HCl.$$

A white irritant gas 100 cub inches
of which weigh 39.6 grains. Liquefies
at about 50° Fahr under 40 atmospheres
Neither burns nor supports combustion
Water at 40° Fahr absorbs about
480 times its bulk and swells 1/3.

Oxides of Chlorine

Chlorine does not combine directly with oxygen. Its oxides are three

Cl_2O Hypochlorous Anhydride

Cl_2O_3 Chlorous "

ClO_2 Peroxide of Chlorine

A molecule of water added to the first forms Hypochlorous Acid $Cl_2H_2O_2$ a powerful oxidizer. Chlorine gas passed over Oxide of Mercury yeilds the Cl_2O. Hypochlorous ~~add~~ acid forms the Hypochlorites. Bleaching powder is an example as

$$CaH_2O_2 + 2Cl_2 = Ca(Cl_2O_2) + 2H_2O + CaCl_2$$

Slaked Lime — Bleach. Powd.

Chloric Acid $HClO_3$

The acid radicle of the Chlorates.

To form Chlorate of Potass ~~the~~ Slaked Lime and Chlorine are used as

$$3Cl_2 + 6KHO = 5KCl + KClO_3 + 3H_2O$$

Chlorides { Chlorate

But as the waste of Potassium is large Potass Caik and Slaked Lime are used as

$K_2CO_3 + 6C_2H_2O_2 + 6Cl = CaCO_3 + 2KClO_3 + 5CaCl + 6H_2O$

Perchloric Acid — Chlorate

Obtained from Pot Chlor by heat: $HClO_4$

$2KClO_3 + heat = KClO_4 + KCl + O_2$ the Klt $KClO_4$ being its salt of Potassium

A body known as Chloride of Nitrogen a violent explosive is also made its formula probably being HCl_2N, Cl_3N

Bromine Br 80 Sp.G. 3.187

A Liquid element from seawater discovered by Balard in 1826. The Bromide is obtained and then heated with Binoxide of Manganese and Acid Sulphuric

$2KBr + MnO_2 + 2H_2SO_4 = K_2SO_4 + MnSO_4 + 2H_2O + Br_2$

Bleaches like Chlorine. Hydrobromic Acid is now used in medicine. HBr being the formula. Bromine in Solutions is fed by Chlorine and then shown by Carbon Bisulph or Ether.

Iodine I 127 Sp G 4.94

Discovered by Courtois 1811

Obtained from Seaweeds, in a combination chiefly with Sodium May be free as the Bromine

$$2NaI + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + I_2$$

Iodine is a solid fusing at 270° and boiling at 347° Fahr. Chlorine frees it in combination and starch turns blue with it. Lead salts give a yellow and Bichloride of Mercury a red precipitate with and Iodide Hydriodic Acid HI is made as follows

$$8KI + P_2 + 10I_2 + 16H_2O = 2KH_4PO_4 = 28HI$$

Iodates blue with Tartaric acid while Iodides do not.

If a solution of Iodine Bromine and Chlorine is mixed they may be detected by Ag precipi-

Tating the Sodine with two parts Sulph. of Iron and one of Sulph Copper Nitrate of Silver precipitates the others. Silver Chloride is soluble in Ammonia

Fluorine F 19 Spg 1.313

This ~~metal~~ element has never been seen ~~not~~ nor an oxide of it. It is found as Fluor Spar in combination with Lime CaF_2. An acid Hydrofluoric is used in etching Glass {HF 20} $CaF_2 + H_2SO_4 = CaSO_4 + 2HF$. a volatile irritant colourless acid Spg 1.06 Should be made in lead apparatus.

Sulphur S. 32

Sulphur is found native combined with Iron Copper Arsenic &c in the form of Sulphides. Sulphur is a non conductor of ~~heat~~ electricity and if rubbed becomes neg. elelic. Specific gravity about 2.05. Sulphur is allotropic being known in crystal also in an amorphorous powder and if heated and slowly dropped in water forming a plastic mass with a density of 1.96.

Sulphur forms compounds with Iodine & Chloine

Sulphurous Gas SO_2 64

An easily condensible gas Density 2.247. ~~Oxcake~~ May be made from Carbon and Sulphuric Acid

$$2C + 4H_2SO_4 = 4SO_2 + 4H_2O + 2CO_2$$

or from Sulphur and Binoxide of Manganese

$$S_2 + MnO_2 = SO_2 + MnS$$

This gas bleaches colours but ammonia restores them it is also a disinfectant a solution of this forms the sulphurous acid H_2SO_3 of the Pharmacopeia

Sulphuric Acid H_2SO_4 98

This acid used largely in chemistry is prepared in large leaden chambers from heated Sulphur and Nitric Acid with air and steam. Sulphurous gas is first formed which unites with one molecule of oxygen from the nitric acid forming the Sulphuric

$3H_2SO_3 + 2HNO_3 = 3H_2SO_4 + H_2O + 2NO$ and the nitric oxide formed unites with the air and water forming Nitric Acid again. Hardhaven acid the strongest Sulphuric if distilled yeilds water and anhydrous Sulphuric Acid SO_3. Iron Lead. Sulphurous Gas are impurities. Sulphocyanide of Potassium detects Iron, water lead

Hyposulphurous Acid $H_2S_2H_2O_4$

Pass Sulphurous gas through a Sulphide

solution.

Hyposulphuric Acid $H_2S_2O_6$

The tests for Sulphates is Chloride of Barium. Insoluble precipitate in HNO_3

Sulphides are tested with a mineral acid Sulphuretted Hydrogen being fued

Sulphites with mineral acids Sulphurous acid being fued

Hyposulphites mineral acids give off SO_2 and Sulphur is precipitated

Hyposulphates no change with mineral acids unless heated then SO_2 is fued.

Phosphorus. P. 31 Sp. G. 1.83

Discovered by Brandt in 1669. Exists in bones as Phosphate of Calcium. It is a nonconductor. Soluble in Ether Turpentine Carbon Bisulph and Oils. It is luminous and allotropic. By heating it to about 300° it turns red and forms the amophous Phosphorous. 2.13

Phosphoric Anhydride P_2O_5

The ordinary phosphoric Acid is made by heating Phosphorous and Nitric Acid together

$$P_6 + 10HNO_3 + H_2O = 6H_3PO_4 + 10NO$$

H_3PO_4 or Orthophosphoric is the acid of the Pharmacopeia, it gives a yellow precipitate with Nitrate of Silver

H_2PO_3 or Metaphosphoric Acid gives a white precipitate with $AgNO_3$ but coagulates albumen

$H_4P_2O_7$ or Pyrophosphoric acid gives a white precipitate with $AgNO_3$ but does not coagulate albumen

Boron B 11

Discovered by Davy in 1808. Is allotropic
Langley found as Boracic Acid or
as Tinical. It is found in all
volcanic regions especially in
Italy near Tuscany
Boracic Acid HBO_3 1.48.
Obtained largely from the volcanic
districts in Tuscany, it reddens
Turmeric paper and burns green
Sometimes used to adulterate Salicine
Borax or Biborate of Soda with
the formula $Na_2B_4O_7 + 10H_2O$ found
native but requires purifying it
is soluble in 2 parts hot water and
in 12 cold. If a solution of Sulph-
uric Acid is added to it, Sulphat-
or of ~~Boron~~ Soda is formed and
the Boracic Acid set free

Silicon Si 28

The most abundant element, it is allotropic. Its oxide Silica or Silicic acid is the base of many rocks. It is nonvolatile Soluble only in Hydrofluoric Acids. It is the base of Glass. The best Bohemian has Silicu Potassium and a little Magnesium Sodium Another variety of Bohemian has aluminium in addition. A third has Calcium Sodium and Silica, Plate glass. Crown Carboy glass has Iron ore and other impurities. Flint has lead and Potassium Glass is slightly soluble in water Silicofluoric Acid is a compound of Sulphuric Acid Spar and Silica

$2H_2SO_4 + SiO_2 + 2CaF_2 = SiF_4 + 2CaSO_4 + 2H_2O$

$3SiF_4 + 2H_2O = 2(2HF + 2SiF_4)SiO_2$

Selenium Tg. 5 Sp G 4.7 Berzelius in 1817 found as Selenides of Lead & Copper in Mexico & Sweden. Sublimes scarlet

Tellurium 129

Exists as tellurides in Hungary remarkable for the strong disagreable odour it gives to a person who is dosed with it. Along with Selenium it forms one of the Sulphur group and its chemistry is similar

Potassium

K 39 Spec Grav. 865

Fuses at about 144° Fahr, Found in the Alum Felspar Mica. Oxidizes so readily that it must be protected by a Hydrocarbon. Inflames if placed in water. Discovered by Davy 1807

Made be made by decomposing Bitartrate of Potassium ~~with Carbon~~ Its oxide has the formula K_2O this with a molecule of water forms the Caustic Potash $K_2O + H_2O = 2KHO$

or from Pot. Carbonate and Hydrate of Lime

$K_2CO_3 + CaH_2O_2 = 2KHO + CaCO_3$

If Silica be present in the caustic potash an excess of ~~Caustic pot~~ Acid will precipitate it out

Alumina and Iron neutralize the solution and add sol of Ammonia. Lead heat for with Sulphuric Acid

Oxalate will detect Lime the precipitating being soluble in Acid Hydrochlor not in acetic. Potassium is found in woods principally as carbonate though Sulphate and Chloride are formed

Sulphide of Potassium KS_3 B.P.

Mr Watts gives the formula for the above as K_2S_3 his way is as follows with Carbonate of Potass and Sulphur

$3K_2CO_3 + 4S = \cancel{2KSO_3} + 2K_2S_3 + KSC_2S_3 + 3CO_2$

Iodide of Potassium KI 166

Can be prepared from Iron Iodine + water $Fe + I + H_2O$ = Iodide of Iron the add Potass Carbonate takes Oxygen from Iodine and Caustic Potash

$3I_2 + 6KHO = 3KI + 3KIO_3 + 3H_2O$

The Iodate KIO_3 may be ~~transform~~ changed to Iodide by heating with Carbon

$2KIO_3 + 3C_2 = 2KI + 6CO$.

Likes formula condensed is as follows

$7Fe + 4I_2 + 4K_2CO_3 = 8KI + 7FeO_4 + 4CO_2$

Iodates turn blue with Acid Tart and starch

Bromide KBr

Obtained like the Iodides ~~Ab~~

By passing Sulphuretted Hydrogen through Bromate of Potassium the Bromide is formed

$2KBrO_3 + 6H_2S = 2KBr_2 + 6H_2O + 3S_2$

Carbonate K_2CO_3

Sulphate K_2SO_4 crystallizes out in making Carbonate from wood

Chloride of Platinum forms with the Chloride of Potassium a reddish Chloride of Iodth.

The Bisulphate $KHSO_4$ is the residue from making Nitric Acid.
Nitrate of Potassium KNO_3 is found largely in nature but requires purifying.

Sodium

Na 23 Sp.G. 972 Fuses at 200°
Discovered by Davy in 1807
Largely found as Salt Borax Cryolite
Cubic Nitre
Sodium Chloride NaCl or common salt soluble in three parts of water precipitates if heated and is the source of the Sodium Salts. A subchloride Na_2Cl can be formed. Its combinations with Iodine and Bromine are like the Potassium salts
Sulphate $Na_2SO_4 10H_2O$ or Glauber salts or Sal Mirabile a by product in the manufacture of the Carbonate $2NaCl + H_2SO_4 = NaHSO_4 + NaCl + HCl$

$NaHSO_4 + NaCl = Na_2SO_4 + HCl$

Sulphite Sodium Na_2SO_3

Nitrate " $NaNO_3$ found in Chili as cubic nitre

Carbonate Na_2CO_3 $10H_2O$

$Na_2SO_4 + 2C + CaCO_3 = Na_2CO_3 + CaS + 4CO$

The acid carbonate or washing soda is insoluble in spirit $NaHCO_3$

If Sulphide is present in the carbonate Lead or Bismuth give black precipitates

Phosphate Na_2HPO_4 $12H_2O$ from phosphate of Lime and Acid Sulph.

$3(Ca_3P_2O_4) + 6H_2SO_4 = 6CaSO_4 + 3(CaH_4P_2O_4)$

$3(CaH_4P_2O_4) + 4(Na_2CO_3) = 4(Na_2HPO_4) + Ca_6(PO_4)_2$

Ammonium Chloride NH_4Cl

This chloride changes such salts as Stannates arsenites and Antimoniates to volatile chlorides If heated with the oxides with a formula similar to ZnO it forms solid chlorides NH_4NO_3 Nitrate of Ammonia melts at 246° Fahr. NH_4NO_3 heated splits into laughing gas $2H_2O$ and water H_2O $N_4H_{16}C_3O_8$ the commercial carbonate of Ammonia made by subliming Chalk $CaCO_3$ and Chloride of Ammonia NH_4Cl & it consists of two molecules of the carbonate $2NH_4HCO_3$ and one of the carbonate called Carbamate $NH_4NH_2CO_2$ as $NH_4NH_2CO_2$

$$\frac{2NH_4 \cdot HCO_3}{N_4H_{16}C_3O_8}$$

The principle impurities of the above are found as chlorides and Sulphates Chloride of Platinum gives a yellow precipitate with Ammonia which

if heated leaves platinum.

Barium Ba 137 Davy.
A yellow metal forms a basic oxide BaO also another one BaO_2. A sulphide of Barium may be prepared by heating the sulphate with Carbon
Barium gives a green yellow to flame. and its salts are precipitated by Sulphates Phasphates and Carbonates but not by Sulphide of Ammonium. They are also poisonous. Its Chloride $BaCl_2$ precipitates with the yellow chromate of Potash.

Strontium. 87.5 Sr. Spg 254

Forms no peroxide.

Nitrate $Sr 2NO_3$ is largely used for colouring fires it gives a red tint

Its salts are not poisonous and the do not precipitate with Potass. Chrom.

With Sulphate of Calcium it gives an immediate precipitate

Calcium Ca 40

Yellow and malleable forms only one oxide CaO which with a molecule of water gives $Ca H_2 O_2$ Slaked Lime

Its sulphide CaS is used as a depilatory. Carbonate $Ca CO_3$ is found largely natur as maible chalk etc. Its phasphate $Ca_3 \& P_2 O_4$ or apatite is also nature. Lime does not precipitate with Ammonica Sulphate of Lime or Sulphide of Ammonium nor with chromate of Potassium. White precipitate with Phosphate Carbonates Oxalates.

Aluminum Al 27.5

Sp.g. 2.5 Discovered by Woohler
It is malleable ductile and sonorous. Oxidizes slowly, nitric acid has no action on it
Chloride Al_2Cl_6 soluble in caustic potash.
Oxide Al_2O_3 found combined with silica, is soluble in caustic potash not in Solution Ammonia
Its sulphate is found combined with Potassium and Ammonium which when refined give the alum of Commerce with the formulas
K $Al2SO_4 + 12H_2O$ and $Al, NH_4 2(SO_4) 12H_2O$
If its oxide is heated on carbon it turns blue with nitrate of Cobalt. White precipitate with Sulphide of Ammonium, also one with Caustic Potash soluble in excess.

Magnesium. Mg. 24

found in dolomite as a carbonate also in sea water and various springs as Sulphate etc. It burns with a brilliant white flame and is soluble in Acids or Chloride of Ammonium

Mg O Oxide soluble in acids with no effervescence

Carbonate ~~s~~ soluble $MgCO_3$ $mgO + 5H_2O$ prepared of different densities

$MgSO_4 + 7H_2O$ soluble in 8 parts of water. This is the Epsom salts of commerce. Precipitated with Ammonia insoluble in excess.

Magnesia is precipitated with caustic alkalies soluble in excess White precipitate with Carbonate of Soda or Potash if Ammonia is absent.

Zinc 65 Sp.gr 6.8 to 7.1

Found in various forms as Calamine Carbonate from Belgium also as Blende as Red Oxide in New Jersey. Zinc volatilizes. It is soluble in solution of caustic potash forming a salt of the formula K_2ZnO_2. Zinc is used in making German Silver and Brass. It is also used as a pigment. It forms a white sulphide

ZnO Oxide of Zinc formed by burning Zinc in air. This is apt to be impure as Arsenic Lead and Cadmium are often associated with Zinc

$ZnCl_2$ Its Chloride is a powerful disinfectant it is also poisonous. Carbonate of Soda Emetics and demulcents are good antidotes

$ZnSO_4, 7H_2O$ Sulphate of Zinc soluble in 2½ pts water is a powerful emetic; to distinguish it from Epsom dissolve and precipitate with NH_4 the

precipitate is soluble in excess
Carbonate $ZnCO_3 + 2ZnH_2O_2$ prepared from Sulphate of Zinc and Carbonate of Soda

$$2H_2O + 3ZnSO_4 + 3Na_2CO_3 = ZnCO_3 + 2ZnH_2O_2 + 3Na_2SO_4 + 2CO_2$$

Native carbonate or calamine has the formula $ZnCO_3$. A silicate is also known $Zn_2SiO_4 \cdot H_2O$
Acetate formed by dissolving Carbonate or Oxide in Acetic Acid $ZnC_2H_3O_2$ also the Valerianate $Zn(C_5H_9O_2)_2$
Zinc salts are astringent emetic poisonous.
Zinc in acid combinations ~~white precipitate~~ not precipitated with Sulphuretted Hydrogen Gives a white precipitate with Ammon Sulphide
" " " with alkalies soluble in excess
" " " " Na_2CO_3 or K_2CO_3 insoluble " "
" " " " " $K_4FeC_6N_6$.

Cadmium 112 yellow 8.6 discovered by Stromeyer found in Zinc ores as a Sulphide; is soft malleable ductile cracks when bent fuses at 242°
Its Iodide is made by direct union

and is soluble in water and spirit precipitates with Sulphuretted Hydrogen

Cobalt 58 Brande 1793
Found in Germany combined with Arsenic and sulphur as Glance, nearly infusible hard brittle and magnetic, freely soluble in HNO_3 Solutions of its Chloride or Nitrate are blue but turn pink if ~~heated~~. diluted Forms red crystaline salts. Gives no precipitate with H_2S in acid combinations. Black precipitate with Sulph-hydrate of Ammonia. Blue with KHO insoluble in excess. Blue with solution of Ammonia sol in excess. Green with $K_4FeC_6N_6$.

Nickel 5·8 Germany
Forms green salts with acid reactions
No precipitate with H_2S.

No precipitate
Pale green precipitate with KHO insol in excess. Dirty green with $K_4 Fe C_6 N_6$

Iron. Fe 56.

Found in the blood also associated with platinum copper sulphur etc and as Magnetic Oxide Fe_3O_4 ($FeO + Fe_2O_3$) in Sweden and N America or as Iron sand in the Indies Specular metal or anhydrous Fe_2O_3
Haematite from Lancashire anhyd Fe_2O_3 and also in Cornwall, as brown Haematite in France $2 Fe_2O_3, 3H_2O$
Spathic $FeCO_3$ Crystalline in Saxony.
Clay Iron Stone impure Carbonate with 33 pc Iron. Black Band in Scotland containing 25 pc Bituminous matter. Iron combines as Ferrous or protosalts as bivalent, and Ferric or per salts bivalent.
FeO or Ferrous oxide is not easily obtained as it readily oxidizes. Adding caustic

potash to a pure solution of a ferrous salt a hydrate is obtained FeH_2O_2
Fe_3O_4 Magnetic forms no salts.
FeS or sulphide used only in preparation of Acid Sulphuric.
$FeSO_4\ 7H_2O$ or green vitriol soluble in 3 parts water not in Acids.
Phosphate $NaHPO_4 + FeSO_4 = FeHPO_4 + NaSO_4$
or the new method
$3FeSO_4 + 2NaHPO_4 + 2NaC_2H_3O_2 = 3Fe(PO_4)_2 + 3NaSO_4 + 2HC_2H_3O_2$
$FeCO_3$ its carbonate is obtained by mixing sulphate with an alkaline carbonate.
Ferric Chloride Fe_2Cl_6
Heat Iron and pass Chlorine through it or
$6FeCl_2 + 6HCl + 2HNO_3 = 3Fe_2Cl_6 + 2H_2O + 4H_2$
Sulphate Monsels Styptic
$6FeSO_4 + 3H_2SO_4 + 2HNO_3 = 3Fe_3(SO_4) + 2H_2O + 4H_2O$
Hydrated Peroxide $Fe_3H_2O_2$
$Fe_3SO_4 + 6NaHO = Fe_3H_2O_2 + 3Na_2SO_4$

Nitrate formed by combination of the metal and acid $3Fe + 8HNO_3 = 3Fe(NO_3)_2 + 2NO + 4H_2O$

Ferrous salts precipitate gray changing to red by NH_4 Ferricyanide of Potash $K_6Fe_2C_{12}N_{12}$ blue with Ferrous salts

Sulphuretted Hydrogen changes the ses to the protosalts sulphur precipitated Black precip with NH_4HS. Red with Sulfocyanide of Potash. Blue with K_2FeCy_6

Ergot.

This peculiar growth has been observed in many parts of the world, through the continent of Europe from Spain to South Russia, far up into Norway, and in the higher valleys of Switzerland. The fungus has been found in England and in S. Eastern Africa. I do not know if it is indigenous in America having met no note on the subject in collecting information for this paper.** Probably no article in the Pharmacopeia has been so much or so variously commented on as our subject, what it is? how produced? its therapeutic value + constituents, all have been in turn bases upon which theories plausible ingenious + widely divergent have been built, and no sooner built than criticized and called in question + newer ones brought forward in their place

xx This continent being favorable to the growth of all cereals, ergot is probably met with, though not collected.

This constant investigation has proved so beneficial, that Ergot, its production & usefulness are well understood, and it holds in consequence a firm place on our list of reliable medicines

Its Pharmacopeial definition is rather startling & requires some acquaintance with a botanical dictionary to understand especially as the revisors of the 1885 edition have pruned away the explanatory clause in the older works referring to the sclerotium. You can all call it to mind. "The sclerotium of the Claviceps Purpurea Tulasne, produced between the pales, and replacing the grain of the Secale Cereale". I would first call your attention to the name Tulasne to that careful investigator, we owe much of our knowledge of this singular growth his "Memoire sur l'Ergot des Glumacées having established the fact that ergot as we have it, is the second or inter-

mediate

stage of a biennial fungus.

In an ear of ergoted rye only a few grains are usually attacked, sometimes over twenty, & not the remaining grains are not affected and when the diseased ones are removed can safely be used as food. Should a large number be ergotised the whole ear often decays & rots. It has been ~~been~~ noticed that ergot matures better on isolated rye stalks growing among other cereals. A moist season followed by heat is claimed to be beneficial to ~~the~~ its propagation. In a note to the 6th edition U.S.D it is mentioned that two seasons observations made by Mr Price Wetherall showed that Dwarf Rye sowed very late in the year was largely ergotised while similar crops in the same locality but in earlier escaped.

A mucus called honey dew is the first sign of the parasitic growth

'Flukiger + Hanbury are followed in this description

after a few days this disappears, leaving the grain disintegrated & devoid of starch The ergotised ovaries are covered with and penetrated by a white spongy tissue the mycelium of the fungus. It is made up of thread like cells the outer layer radially divergent. The mycelium forms by its folds & crevices a number of cavities opening outwards. From its outer layer the spermatophorum an immence number of agglutinated granules, conidia, are seperated. The honey dew also contains conidia in abundance but dilution is needful to precipitate and seperate it. The mycelium penetrates the & envelopes the caryopsis with the exception of the apex preventing further growth destroying the epicarp and embryo. At the base of the caryopsis is formed by time function and the gradual transverse seperation of the thread cells a compact kernel like body gradually increasing in size, & seperating from the mycelium as the latter its work done dies up & shrivels. The remains

of the mycelium, and carpospeis and occasionally of a complete grain if one has formed before the fungus attaches itself are met with crowning the apex of the matured ergot. With the next stage we have little to do, but the further growth presents interesting features.

Falling to the ground, the skin after a time, folds back here & there and small heads push out, in a week or two reaching an inch in length. On the surface of the heads are the cavities containing numerous sporules, each sack having eight spores. The spores are discharged united in silky white flocks, and in vast numbers, not less than a million being credited to a single ergot. Having followed the development of the fungus, we may turn for a time to the many theories about its growth in turn admitted and rejected. Decandolle in 1816 thought the ergot was a complete fungus and named it Sclerotium Clavus, Fries follow-ed

this idea changing the name to Sperm
odia Clavus. Leveille in 1827 ~~also exploded~~
~~this view~~. Hucket who called it
Eradochia Abortifaciens claimed that the
growth began with the mycleum spreading
over the grain; and that the sporidia (con
idia) were its reproductive agents, a fact
partly true as Kuhn in 1863 proved that
the mycleum could be grown from the
conidia. Huckett claimed that Ergot is
partly fungus & partly diseased grain,
his reason being the frequent remains of ~~grain~~
the stigma and occasionally of the grain
on the apex of the ergot. The U.S. Dispensatory
of 1846 supports this view. Against it stands
as evidence the fact that neither externally or
internally does ergot bear any resemblance
to a ryegrain; proof ~~being~~ convincing that
the grain is done away with not converted
The theory of insect production was advanced
by Read, and in a work published in
1837 the author says "Read is without

advanced the idea that the mycelium was a complete fungus in its elf.

doubt right. I have frequently observed the insects (Aphis Graminis) at work. Even as late as 1843 in Hookers Dictionary the same view is adopted. The frequent appearance of insects round the honey dew and especially of a red beetle "Rhagonycha Melanura" gave some grounds for this fallacy. Schumann in 1801 appears to have noticed the third stage of the fungus, and conceived it a seperate plant naming it Sphaeria Adam Lonicer of Frankfort in the 16th century describes ergot in the rye fields and remarks that women find it of certain great efficacy in obstetrical cases. Johannes Thalius also makes mention, in the 17th century Caspar Bauhini names it Secale Luxurians and later again Ray the botanist treats of it. Rathlaw an account used it in 1747 and thirty years later Desgranges of Lyons gave it some prominence. To Dr Stearns of Saratoga Co; N.Y. belongs its real introduction in

1807 to the medical profession. It appears in the first U S P 1820 under the heading of Secale Cornutum, Spurred Rye called Ergot. Again in the 1830 edition it is described as a parasitic fungus of the Secale Cereale, and the dose is placed at 10 grs. The London Pharm. adopted it in 1836 as a derivative of the Acenula Clavus of Fries, who it may be said has no such fungus mentioned in any of his writings. About the same date it was adopted by the Edin Ph. as an undetermined fungus with degenerated seed of the Secale Cereale. The U S P 1840 changed its official designation to Ergot in conformity with the British authorities, and placed a wine of ergot among the official preparations, to replace the various tinctures used in the country.

In the USP 1863 Ergot retains its old name, though its designation becomes "the diseased seed of the Secale Cereale". The first BP 1864 has the definition ~~practically as our present authority, & to~~ three of the preparations are still ~~now~~ in unchanged as to strength. The BP 1867 has the definition nearly as the present authority and the U.S. Ps of 1870-1880 are very similar.

The constituents of Ergot have been the field of much research and great difference of opinions has resulted from this ~~much~~ investigation. Buchheim considers that Ergot owing to its low organisation does not form well defined crystalline principles. Wiggers in 1830 obtained an alkaloid he called ergotin, & Wenzell in 1864 obtained two Ether & Echoline, combined with Ergotic Acid. Tanret isolated Ergotinine a crystallized alkaloid 1875. Dragendorff & his pupils furnish the following list of amorphous principles. Sclerotic Acid

as the grain diseased by an imperfect fungus.

Sclerotucin, mucilaginous in its nature
Sclererythrin a red colouring, Sclerojodin
Fuscosclerotinic Acid; Picrosclerotinic
Sclerosanthin & Sclerocrystallin. We
cannot in this paper enter further into
its comparison, that subject alone would
require a treatise to itself.
The peculiar effects of this drug on the
uterus have long been known. As mentioned
before it was employed by German midwives
two centuries ago, it common German name
mutter or womb corn being derived from
its use. A writer early in the century
states that it is used in America to
produce abortion. Its efficacy in assis-
ting childbirth has been disputed by
many writers; one a German going so
far as to say that it has no connection
with the uterus except through the name
mutter common to both, but testimony
in its favor far outweighs any inimical
to its reputation. Ergot has been employ-
ed

in checking haemorrhages through its action on the muscular coats of the bleeding arteries for the expulsion of coagula of blood, polypi or hydatids from the uterus. Success is claimed for it in paralysis of the bladder Goitre haemorrhoids and some skin diseases, as a poison Ergot has had a wide field for mischief, and it has ~~done~~ caused much illness and death. Its operation is chiefly on the nervous & circulatory functions and it seems to act in two distinct ways, one sometimes called convulsive ergotism manifesting itself in giddiness insensibility convulsions & rapid death, the other gangrenous, in which pains and fever, with formation of dry gangrene on the limbs & joints the parts attacked blackening & drying & falling off. These last symptoms are also noticible in animals affected by ergot. The gangrenous complaint generally arises from the use of ergotised flour and has been known for many years under such

names as, "Morbus Spasmodicus", epidemicus vel convulsivus, "Raphania", "Ignis" "Sancti Antonii". The epidemics in Europe during the 6th and 8th centuries are attributed to ergotism, & evidence points to our subject as the cause of the plagues in France in the 10th and in Spain in the 12th centuries. Hesse suffered severely in 1676 from a pestilence which the Marburg Med: Faculty considered ergot to blame for. Further epidemics are reported in Germany in 1648, 49, 75; 1702-16-17-22 36 & 41; in France in 1630 & 1816. More recently cases have been met with in Bavaria & Abyssinia. In Germany poisoning is said to take place by contact such as sleeping on attacked grain, and a case is recorded of where ergot carried in the pocket gave rise to unpleasant symptoms which lasted till the pocket was well washed.

Ergot has several officinal preparations in both the US & BPs, The oldest being the wine introduced into the 1840 Ed

Ordr

of the U.S.P. with a strength of 2ʒ to the pint, Sherry in 1850 this was reduced to half its strength, restored at the next revision; changed in 1870 to 4 fl ozs extract to 28 fl oz Sherry and in the last edition changed again to powder and strengthened to about 4ʒ two & a half oz to the pint; its dose 1 to 2 fl drams remaining unaltered. The preparation is not much employed and I do not remember a call for it in the 8 years experience

The Fluid extract is decidedly the leading preparation of ergot. In the U.S.P of 1860 it was ordered to be made with Dilute Alcohol & Acid Acetic, and in 1870 ʒj Glycerine to the pint were added. The acetic acid was ordered to prevent volatilization of the trymethylamin but its addition is of doubtful value. The Glycerine was rather useless than otherwise as it prevented concentration if necessary for hypodermic or other use. The presence of Acid Muriatic

Trimethylamine is yielded if ergot or its alcoholic extract, is treated with an alkali and is a product of the decomposition of albuminoid bodies, some writers have endeavoured to prove its existence in ergot as a phosphate but Jaugell ascertained that no such base pre-exists.

extract
in the new official edition of the U.S.P is
said by Tuttle & Maisch to be valueless, the
alkaloids of ergot being non volatile while
trimethylamin is a product of decomposition
and does not probably contribute to the activ-
ity of the medicine. The L.P preparation
was to be obtained by first extracting the fixed
oil with ether and then, percolation with
water, condensation and sufficient spirit
added to preserve it; but the 1885 edition
has a much simpler process, viz extraction
by water & preservation by spirit. The absence
of mineral acids & its easy concentration render this
The dose varies; an interval of ½ hr
repeated at short intervals is recommended
but as high as 8 drams has been used
in other complaints

The infusion ~~does not~~ only appears in
the B.P. & has remained unchanged since
its introduction in the original edition
½ to 1 oz to 10 fl oz boiling water. Tincture Ergot
is also a B.P. preparation, 5% to the spirit.

probably the most useful formula yet prescribed.

The authorities in this case have ordered the ergot to be more finely divided in each revision starting with bruised, then in coarse ~~powder, & finally~~ & ending in fine powder the object being a more thorough exhaustion of the active ingredients.

Ergotin was added to the USP 1880 to ~~rep~~ give an official preparation for Bonjeans Ergotine, The fl extract is taken, evaporated down and after mixing with spirit, further evaporated to a suitable consistency, a hypodermic solution made by dissolving 1 pt of this into 6 camphor water is also in the new edition.

An extract of ergot is also in the USP 1880 prepared from the fl extract 5 to being reduced to one by evaporation, its dose is given from 3 to 15 grains.

The liability of ergot to spoil renders it necessary to be very careful ~~with~~ in its ~~pre~~ preservation. Some authors claim that after a year its activity is impaired

Pour parvenir

but the chief danger comes from a small mite
a species of Tromidicum which eats the interior
leaving only the thin external shell. The powder
is also liable to attacks from insects, and
to lose its usefulness from the to rancidity
of the fixed oil contained. Camphor is a
good safeguard from the insects and the
rancidity may be avoided by powdering
only as required.

The supplies of ergot are drawn from Tenerife
Spain, Hamburg, France & Russia. The amount
yearly imported to this continent is between
90 & 100000 pounds, having increased from 10000
pounds ~~to~~ to twenty years ago. Its price has greatly
decreased since its first introduction, the
price in London 60 years ago being 50/- p
lb.

Before leaving this paper reference must be
made to ergot in other plants, Prof Hart gives
a list of fourteen genera of grasses certainly attacked
& mentions one or two more as doubtful.
Ergot of Wheat is claimed by Tarbonneau

Le Perdrel to be less prone to deterioration & to be free from the poisonous qualities of rye ergot Prof Beckly has found that wheat ergot kept its qualities unimpaired for ten years during which time a sample of the officinal, under the same circumstances was totally destroyed Wheat ergot is shorter thearier than rye, rarely more than one in an ear & that generally in very damp weather. In Italy it is picked by hand from grain used in the vermicelli manufacture

Ergot of Oats, as found is much more slender than the rye ones, it is generally sold mixed with though occasionally a sample free from rye is met

Ergot of Diss a north african grass is from 1 to 3 inches long by 1/10 in broad curved & twisted spirally, according to Tallemant its activity is double that of rye. Corn Ergot lately used to some extent is not an ergot at all, but a complete fungus of the order Hetelasporiae