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LECTURES.

Delivered at the

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by

Professor Frankland.

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George M. Dawson.

VOL III

NOTES OF CHEMICAL

WILLIAMS

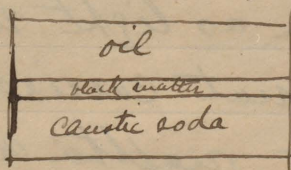
Lecture XII

February 21st 1870.

Paraffin Is most largely obtained from two varieties of Cannel coal. The Boghead from near Edinburgh, & the Leeswind from N. Wales. Indeed it is probably not profitably obtained from any other source.

The petroleum, or rock oils also contain it. The methods used for its extraction from the Boghead Cannel are as follows. The coal is subjected to destructive distillation at as low a temperature as possible. The tar thus obtained is placed in suitable vessels, & a current of steam passed through it. All the more volatile products are carried over with the steam, & known as light naphtha. This process is frequently not carried on long enough, as the light naphtha does not sell as well as the other products.

The residue is then treated with SO_2H_2 . These heavy compounds consist mostly of the $\text{C}_n\text{H}_{2n+2}$ & C_nH_{2n} series. By the action of the SO_2H_2 the C_nH_{2n} family, which are comparatively unstable are charred & destroyed. The $\text{C}_n\text{H}_{2n+2}$ series, (which have before been compared to the noble metals are unaffected). The liquid is then well washed with hot water, to free it from acid, & next treated with caustic soda. This combines in some way not very well understood with the black charred matter, & the liquid resolves itself into three layers, as below.



The oil is then rectified & gives rise to three classes of compounds

1st illuminating oil. 2nd paraffin
oil. 3rd Paraffin.

The paraffin oil deposits paraffin crystals
on cooling, & the paraffin itself solidifies.

The Paraffin is freed from a portion of the
oil with which it is mixed, by pressure,
& from the remainder by a centrifugal machine.

It is then placed in matting between
pollow iron plates, through which a current
of ^{hot} water passes, & subjected to hydraulic
pressure. This removes the last traces of
the heavy oils. The residue is again
treated with two percent of $\text{SO}_2 \text{H}_2$. & well
mixed with some lighter oil which is
distilled off. It is then filtered through
animal charcoal, kept heated by means
of steam. It is lastly melted & currents
of superheated steam passed ^{through it} which remove
the last of the light paraffin.

Paraffin melts between 45° & 65° Cent
is soluble in alcohol & ether, but
not in water. SO_2 & H_2O_2 has hardly any
action on it. Concentrated NO_2 & H_2O changes
it ^{slowly} to succinic & butyric acids. It is
colourless, & not easily inflammable in
a mass but burns from a wick with
a clear luminous flame. It is the
most luminous of all the fatty substances
employed for making Candles, as it
does not contain any O which all the
others do. Oxygen is exceedingly prejudicial
to the luminosity as it combines in the
flame with the C, & thus diminishes its
light.

Paraffin oil is employed for the lubrication
of machinery, but not to so great an
extent as formerly, on account of the
very disagreeable smell large quantities
of it gives in factories &c. It is

not quite equal in lubricating power to the best sperm oil.

Illuminating, or burning oil consists of the lower members of the marsh gas series. Its introduction has created a revolution in illumination second only to that caused by the introduction of coal gas. It is now met with everywhere, even in the dwellings of the very poor.

Its relative advantage will be shown by the following table. For the same cost you get the light of 5 tallow or sperm candles.

Youngs paraffin oil	1 gal 8029 lbs
American rock oil	1.26
" " " inferior	1.30
Paraffin candles	1806 lbs
Sperm "	22.9
Wax "	26.4
Stearine "	27.6
Composite " (stearine & tallow)	29.5
Tallow "	36

The larger the amount of material that can be burned from one flame the greater the economy of material. For when the same amount of illumination is accomplished by a number of small flames, the cooling & oxidizing effect are vastly increased.

Table of the relative cost of various materials required to give an amount of light equal to that given by 20 sperm Candles burning at the rate of 120 gms per hour for 10 hours.

Wax	4	2
Spermaceety	7	" 2½
Tallow	6	" 8
sperm oil	2	" 8
Coal gas	1	" 10
Cannel gas		4¼
Paraffin		3
Paraffin oil	3	" 10
		5-

The gas at the London prices.

CO₂ & heat evolved by the combustion of various materials, giving a light equal to 20 standard Candles.

Weight per hour	Cubic feet of CO ₂	Heat
Tallow	10.1	100
Sperm-cety } Wax }	8.3	82
Paraffin	6.8	66
Coal gas	5	47
Cannel gas	4	32
Paraffin } Rock oil }	3	29.

Great quantities of petroleum & allied substances, probably produced by some natural process of distillation are obtained from Canada, United States, Burma, Russia &c. Canada alone at an early period in the trade produced ^{in one year.} 20,000,000 gallons equal when purified to ~~the~~ 180,000,000 pounds of sperm Candles.

Hydrides of the Phenyl Series

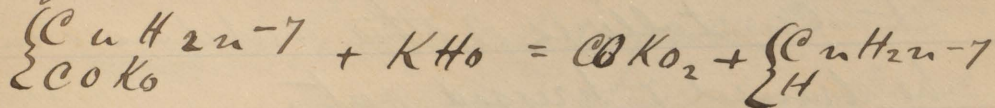
Pentol	C_5H_4	boiling point 60° Cent
Benzol	C_6H_6	80.5
Lolual	C_7H_8	110
Xylol	C_8H_{10}	128.5
Culol	C_9H_{12}	148.5
Cymol	$C_{10}H_{14}$	171.4

These are produced in the distillation of coal &c. They yield much more readily to acids, & are thus more interesting in a chemical point of view.

Benzol is the most important. It is a product of the destructive distillation of coal. It was first discovered by Faraday in 1825, & was obtained by him in his experiments on the compression of coal gas. He called it "bicarburet of hydrogen" as according to the notation then in use the combining weight of C was 6.

It may be obtained pure by heating

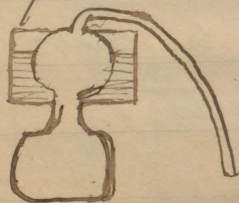
benzoic acid with three parts by weight
of quicklime, thus in the reaction for the series.



Benzol may also be obtained by
passing fats through a red hot tube, this
however is only of theoretical interest.

The great source of benzol is coal tar.

The naptha taken up by the currents
of steam is first treated with $SO_2 H_2O$, &
then with $NaHO$. It is then agitated
with strong $NO_2 H_2O$. decanted, agitated with
strong $SO_2 H_2O$ in certain proportions, &
subjected along with the $SO_2 H_2O$ to distillation.
The still is of a peculiar kind, & the still-
lead must be kept below 110° (as seen
by the boiling point of benzol) which is
done by a vessel of water
surrounding it. all bodies
of higher boiling points here condense
& fall back.



It may be further purified by cooling it to a few degrees below 0° Cent, when it crystallizes, & other substances may be drained & pressed out.

It is a limpid liquid, refracts light strongly, & has a suspended liquefaction. It does not freeze readily till a few degrees about zero (Cent) but does not again resume its liquid condition till the temperature rises to 5.5 degrees. It dissolves iodine, fats, oils &c.

It is very inflammable & burns with a bright smoky flame. It is a useful constituent of coal or canal gas. Even H passed through it burns with a very luminous flame.

The bodies of this series are only second to those of the marsh gas series in their indifference to chemical agents.

Lecture XIII. Feb 22.nd

The Benzol series (C_nH_{2n-6}) are much ^{more} easily changed by chemical reagents than the marsh-gas series. And thus from Benzol alone (which has been most studied) a vast number of compounds are derived.

The most important of these is nitrobenzol because from it aniline is derived.

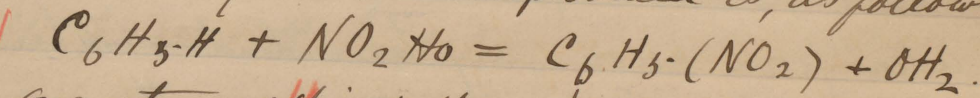
The formula of nitrobenzol is $C_6H_5(NO_2)$ or $N(C_6H_5)O_2$. It may be written in either way, both formulae implying the same.

Nitrobenzol is produced by the action of fuming NO_2H_2O on benzol. The ~~NO₂H₂O~~ ^{substances} should be ^{mixed} ~~added~~ in small quantities to prevent the action from becoming too violent. ~~When it has~~ ~~been~~ ~~pre~~ It does not require the aid of heat. It may be performed, on the small scale, under a bell glass, as shown. to keep in the nitrous fumes.



which are always evolved from the decomposition of a portion of the ^{substance}

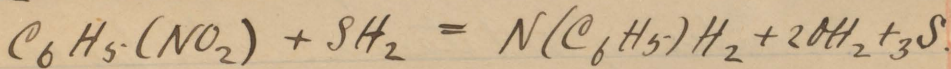
The nitrobenzol is purified by being agitated with water, & then mixed with Calcium chloride, & rectified from it. It is a heavy oily fluid, which sinks in water. It has a yellowish colour & sweetish taste. Instead of boiling at 80° as benzol did, it now boils at 220° . Its vapour density is almost exactly that indicated by theory. 4.4. Compared to air 61.5 to hydrogen. It is much used by perfumers under the name of essence of Nipbane. It is soluble in alcohol & ether, but insoluble in water. The reaction by which it is produced is, as follows.



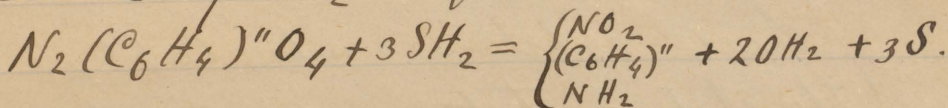
one atom of H is replaced by one molecule of nitrobenzol.

It is transformed by reducing agents into aniline, thus when nitrobenzol is mixed with acetic acid & iron filings

a violent action commences, & does not require the aid of heat. The nascent H liberated by the Fe & 2CO_2 replaces an atom of O. The same end may be accomplished by treating nitrobenzol with SH_2 . Thus






Dinitrobenzol is formed by the combined action of concentrated NO_2H & SO_2H_2 . It crystallizes in long shining needles. Insoluble in water, but soluble in alcohol. When acted on by SH_2 it gives nitraniline.



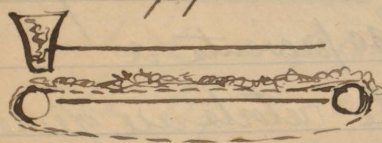
The remaining hydrides of toluol, xylol, & the other bodies in this series have not been much investigated.

Closely connected with these series ($\text{C}_n\text{H}_{2n+1}$ & $\text{C}_n\text{H}_{2n-1}$) are the bodies formed in the manufacture of coal gas.

x The Manufacture of Coal gas. depends essentially on the transformations which organic bodies undergo when subjected to heat. The very complex molecules which may be supposed to exist in coal, canal wood &c are broken up & give rise to a number of substances. The process of destructive distillation to which the coal is subjected much resembles imperfect combustion. The O which is always present attacks as far as it is able the H & C & changes a certain amount of these substances into CO, CO₂, & H₂.

The shape of retort now commonly employed is in section  two other kinds have been in use but they are now superseded by the 3 retorts ( ). The great object is to bring every portion of the coal as rapidly as possible to a bright-red heat. A very ingenious kind has been invented

in which the coal passes through
the retort on a jointed iron platform passing
over rollers the coal being supplied through
a hopper at one end. It does not



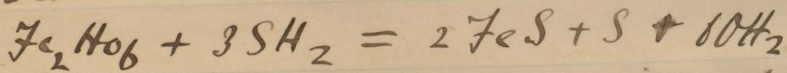
however work well in
practice. The 2 retorts
are generally 20 inches wide by 14 high, &
8 feet long. Some are called double retorts
& are 12 feet long, & charged at both ends.

Five retorts are commonly placed in each
furnace. The retorts were originally made
of iron, but as this corrodes so fast, they
are now made of fireclay. The fireclay
retorts very soon crack, but the cracks
become filled with C from the decomposition
of the gases. Each retort has an iron
mouth-piece, & to this is attached a pipe, called
the "stand pipe" which first passes
upward & then bends over into a pipe of
large diameter called the hydraulic main

which is partly filled with liquid, & under this the end of the stand pipe opens. The gas bubbles up through this & is here partly freed from the tarry matter. The liquid also prevents a back draught when the retorts are opened for a fresh charge. The gas then passes into the condensers, of which there are many kinds, the most common however being the U shaped. In which the gas passes through a great number of U shaped tubes, cooled by water, & their ends opening in a box of water, into which the condensed products drip. In these all the tars & vaporous substances separate, & also a great deal of ammoniacal liquor (CO AmO_2). The gas next passes through the Exhauster. This machine renders the retorts partly vacuous, & favours the escape of the gas.

It is next passed up through two iron cylinders filled with coke, over which water is dripping. These are called the scrubbers, & absorb the ammonia which is produced from the N in the coal. The liquid should be received in a closed tank below, & afterwards pumped up into a cistern, & passed through the scrubbers many times. As it still absorbs the Am & does not stop being at first saturated, abstract any more olifiant gas.

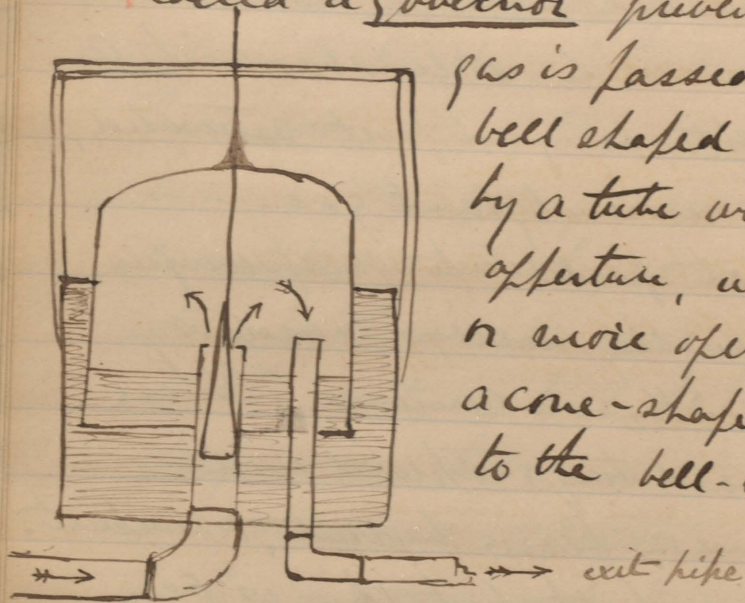
The gas is next passed into the purifier proper, where the noxious, & useless gases CO_2 & SH_2 are removed. These consist of broad trays spread with either quicklime or ferric hydrate, & sulphur. It is best to use both but this is very seldom done



Only about 2 per cent of CO_2 is present in

gas but it diminishes the light by 6 per cent. The gas is next passed through the meter & then into the gas holders. It is not convenient to send the gas directly from these to the consumers as the pressure is apt to vary. A very ingenious instrument called a governor prevents this. The

gas is passed up into a bell shaped receiver, over water by a tube with an annular aperture, which is closed or more opened by means of a cone-shaped valve, attached to the bell-shaped vessel.



The substances generated, in the destructive distillation of coal, in the manufacture of Coal gas are very numerous. In fact 48 different substances are known in the products.

The most important are

{ Marsh gas
Oxygen gas
Hydrogen
Carbon monoxide.

Nitrogen

Vapour of liquid hydrocarbon.

Vapour of Carbon bisulphide.

{ these bodies increase the illuminating power, & give the gas its peculiar odour.

Separated by Condensation & fugifiers

Tar & Volatile oils

Ammonium sulphate, Chloride, & sulphide.

Hydrogen sulphide.

Carbonic acid

Hydrocyanic acid, or Ammonium cyanide

Thiocyanic acid, or Ammonium thiocyanate.

Lecture XIV. Feb 23.

What is the source of luminosity in gas & other flames, & what causes its absence in such flames as H & CO?

The usual explanation is that the hydrocarbons are decomposed at the temperature of the flame, & that the solid particles of C floating about in an incandescent state in the flame, & are the source of the light. Various experiments have been given in proof of this theory. Thus when wire gauze is depressed over a flame, the flame is cut off at that point, & great clouds of black smoke appear.



A luminous flame also deposits a black coat of Carbon on porcelain or any cold surface which is held in it. A non luminous flame becomes luminous when Carbon powder, or other solid substance is sprinkled

into it. There were some of the experiments on which Sir H. Davy founded his theory of the luminosity of flames. And if the black smoke, & lamp-black speaking be assumed to be C, it is no doubt true. Another ~~strong~~ argument in support of this theory is that the spectrum of luminous flames is continuous, which has been considered characteristic of solid or liquid incandescent bodies. Several links in this theory are found to be wanting.

The temperature of a H flame, in air, would be by theory 3776°F . but on account of dissoliation it is much lower (3100°).

When the jet be burned in pure O the temperature should be 7364° , but on account of the same phenomenon is only 5131° .

The steam ^{is not} produced at once completely.

Thus if we take a litre of steam, & heat it to redness, without allowing it to expand

a part of the O & H are disunited,
& are prevented from combining because
so diffused through the mass. As the
temperature is raised still more becomes
separated, till at 5131° only $\frac{1}{3}$ of the
steam remains undecomposed. At 5131°
is the temperature caused by the combination
of O & H, it is evident that only one third
at once enter into combination. The
remainder does so successively as the
temperature falls to a red heat. And
thus it is that the temperature is
much smaller than would be indicated
by theory. When the H flame is burned
in O however, though the temperature is
so much raised the light is not
sensibly increased. When O & H are
exploded no more light results. If
however the O & H be inclosed in a
Cavendish's eudiometer, & there fired without

the possibility of expansion, a very vivid flash of light is produced, & in this flame no solid matter can exist.

When the OxH_2 exploded in the air a great amount of effort is expended in lifting the superincumbent air. As OxH_2 expand to 10 times their volume when exploded, the amount of force expended per cubic inch, is equal to that required to lift 15 lbs through ten inches. The amount of heat required to do this may easily be calculated, & equals that needed to raise a cubic inch of water through 52039°F , & this amount of heat would raise the steam produced to 2231°F . The heat in the radiometer explosion, is therefore 2231° greater than in air. More of the gases also combine at once, & cause a still further elevation of the temperature. But as we have seen temperature cannot, or only in a minor degree, account for increase of light.

The increase of light must therefore be caused to a great extent by the increased density. This may be further proved by analogous experiments with H & Cl , As & O & Co , which when burned in air give little light but intense in the eudiometer.

Thus we have instances of great light where no solid matter is. As is another example, if it be burned in a stream of O it gives a bright light, but no solid particles can be present in the flame, for both As , & As_2O_3 are very ~~so~~ easily volatilized. We have still another instance in CS_2 when burned in air & O or exploded with Nitric oxide.

It is found that substances which have the greatest vapour density give the most light

When the electric spark is passed through
gases of various densities, it gives an amount
of light varying directly as the densities.

Thus it gradually increases with H, Am,
O, SO_2 , Cl, till with Hg the light is
very brilliant, & has even been proposed
under the name of "Ways light" for light houses.
If the sparks be passed through air &
the air gradually compressed the light
augments, as the pressure increases.

Thus we see that though elevation of
temperature augments the light, the density
increases it still more largely. The luminosity
increases directly as the pressure, & when
H is burned in O at 10 atmospheres, it
gives much light, & a continuous spectrum.

The arguments in favour of solid
particles therefore fall to the ground.

We have reason to believe that the source
of the luminosity in ordinary flames

is the mass of dense, but still
vapourous or gaseous hydrocarbons present,
& ignited at a high temperature in the
flame. (Camp black)

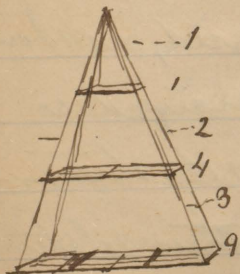
The soot, which is collected from a flame
is also found not to be pure C. For if
it be treated with Cl torrents of HCl
are evolved, even though it has been
for a long time beforehand subjected to an
intense heat. It is such hydrocarbons
which when ignited in the flame cause the
light. It is probable that they are in the
gaseous state but when once condensed
cannot be re-volatilized. It is so with
paraffin. For though it is distilled from
the tar in its manufacture, it cannot
be redistilled without great loss. Pitch
also when once condensed cannot be
re-volatilized without complete decomposition.

It seems indeed to be one of the most difficult problems of Chemistry to separate H & C when once united, & it can only be done by aid of the very powerful affinity of Cl for H, at high temperatures. Another argument in favour of the absence of solid particles from flames, is that flames are transparent, & you may even read through them.

Lecture XV. Feb 24. 1870.

There are two modes in practise for testing the comparative effect of illuminating agents.

Both depend on the law, that the light from any point decreases ^{inversely} as the square of the distance. This may be well shown by a

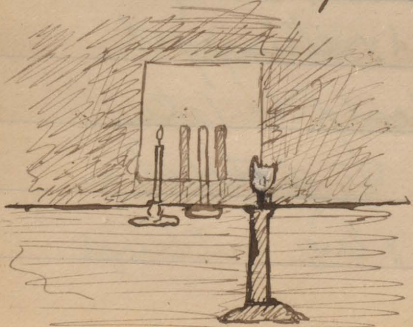


model, or pasteboard & string of this form. This law should be taken into account in the distribution of lights in halls & large buildings.

It is obvious that we can readily ascertain the ^{comparative} illuminating power of two flames, if we can find the respective distances at which the light from them falling on any surface is equal.

The standard of comparison, is, in this country, a spermacety candle of 6 to the pound, & burning at the rate of 120 grains per hour. As no candle however burns exactly at this rate, it is necessary to take the weight of the candle before & after the experiment, & allow for the error.

The first method, for ascertaining the comparative light is called the shadow test. A double shadow of a stick or other object is thrown upon a white surface, by the two flames to be compared, as shown. The lights are then arranged so that the brightness of the shadows is exactly equal, & their relative distances from the surface give the data



Thus the relative distances of a candle, & gas flame, was found to be 16 & 66 inches.

$$16 \text{ squared} = 256$$

$$66 \text{ squared} = 4356$$

$$\begin{array}{r} 256 \) \ 4356 \ (17 \\ \underline{256} \\ 1796 \\ \underline{1792} \\ 4 \end{array}$$

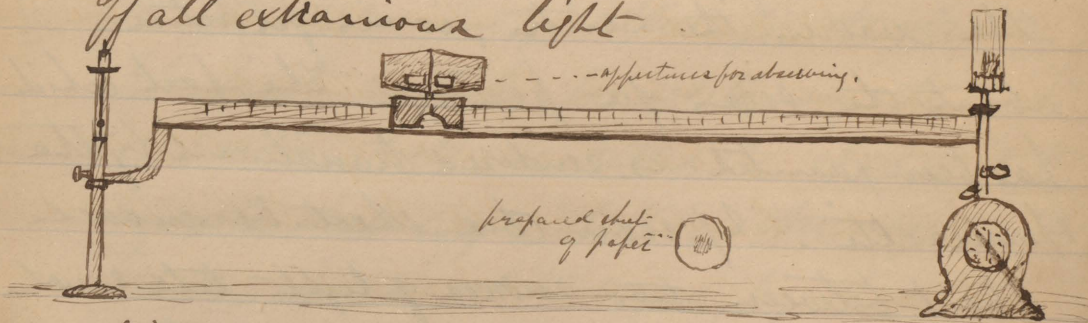
& thus we ascertain that the illuminating effect of this gas flame

is almost exactly 17 times that of the candle.

The Second method, devised by Bunsen is somewhat different. A sheet of paper is painted, with the exception of the centre, with a solution of ~~par~~ spermaceti in turpentine.

The disc in the centre, is in practice about the size of a penny. The part which has been painted is rendered translucent by the spermaceti. If now this sheet be moved about between two sources of light, till equal quantities fall on both sides, the part treated with spermaceti ceases to appear translucent. The apparatus used in practice is as shown on next page. The gas to

be experimented on is passed first
 through a governor, & then through a meter
 so constructed, that it shows by observations
 of a minute the amount consumed
 per hour. This is usually taken at 5
 cubic feet. About 10 observations should
 be taken, at intervals of a minute, & the
 mean of these gives a reliable average.
 The bar on which the disk slides is so
 graduated that the calculations are obviated.
 The use of the enclosing cylinder is to cut
 off all extraneous light.



This method gives very accurate results. The
 most serious error is the irregular combustion
 of the candle, which can only be done away
 with by several observations. In France

a lamp of certain construction is used as a standard & acts much better. The first method is now very seldom used, as there is great difficulty in comparing the ~~fl~~ shades when the flames, as is usually the case, are of different colours.

We have learnt that the degree of light depends on the amount, & quality of the dense hydrocarbons, present in the burning shell of the flame. If double the amount of these be present double the illuminating power is produced. It also depends on the temperature to which they are raised.

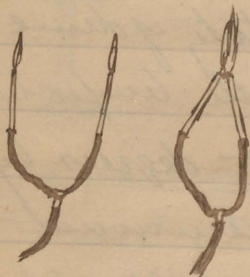
To get the greatest luminosity, we require to get the largest possible quantity of dense hydrocarbons at the highest possible temperature. This is attained to very different degrees by different gas-burners. The amount & quality of hydrocarbons in the shell, depends 1st upon the access of O to the flame, &

2nd ~~It~~ on the velocity with which they are drawn through the flame (the quantity which escape from it in any given time) The access of O to the interior of the flame at once destroys them.

The slower the escape of hydrocarbons from the flame, the greater the amount of light obtainable from any one quantity.

The single jet is the worst & most wasteful form of burner, on account of the velocity of the current of gas, & the quantity of air consequently drawn along with it.

If two of these jets are combined, as shown a great improvement is manifest



The two currents impinging upon each other spread out & to a great extent destroy their velocity. This is the principle of the fish tail burner.

The gain is still greater when the size of

perfect combustion. This is determined by the form of the burner, this also determines the velocity, & the extent & form of surface. The fish-tail is one of the best, but the batswing in which the gas is passed through a very narrow slit almost equals. When the pressure is increased though more gas is burned less light results, on account of the quantity of air drawn in.

It is only recently that this principle has been applied by ~~Scholl~~, & Argand burners supplied with chimneys of different lengths, to regulate the draught. Scholl has recently applied this principle, & diminished the velocity by his "perfector" in which a thin plate of Platinum is placed, on which the currents impinge.

The influence of the pressure of the atmosphere is very great, on flames. And a regular law for the decrease of light, & pressure has been found. The Illuminating power decreases directly as the pressure diminishes. And if the illuminating power at 30 inches of Mercury be stated at 100. Every decrease of an inch of Mercury in pressure, causes a decrease of light equal to $\frac{1}{5}$. The cause of this is that the hydrocarbon vapours have their specific gravities reduced, directly as the pressure. And also there is probably a greater admission of air into the flame, on account of the more rapid diffusion of rare gases. On account of this law gas whose luminosity equals 100 at London only equals, at Munich 91. This is independent of the increase of volume, if only the same volume, was burned the light in the city of Mexico, would only equal $\frac{1}{2}$ of the same volume of gas in London.

This may well be shown by gradually abstracting the air from the ~~the~~ receiver of an air-pump in which a candle is burning.

Pressure of air in inches of Hg	observed illuminating power
30.2	100
28.2	91.4
26.2	80
24.2	73
22.2	61.4
20.2	47.8
18.2	37.4
16.2	29.4
14.2	19.8
12.2	12.5
10.2	3.6

Lecture XVI. Feb 28th 1890

The Two most important conditions of luminosity

The amount & quality of dense hydrocarbon vapours at any particular moment present in the flame, & secondly to what degree of temperature they are raised in the flame.

The composition also probably has some influence. It has not however been much investigated

The smaller the amount of H relatively to the C, the more valuable the hydrocarbon as an illuminating agent. (Thus take the difference between C_2H_4 & C_2H_2) In the process of combustion it is probable that the C goes on being double in proportion by successive subtractions of H, till vapours of exceeding density are ultimately formed.

The density of course depends partly upon the atmospheric pressure.

Dependence of luminosity on temperature.

The light of every luminous body increases directly as the temperature. — It is

however conceivable (though no such thing actually to our knowledge occurs) that the temperature should be raised so high as to cause undulations of such velocity, that they should fall wholly outside the visible violet of the spectrum. The temperature of H burning in air is theoretically about $3376^\circ F$

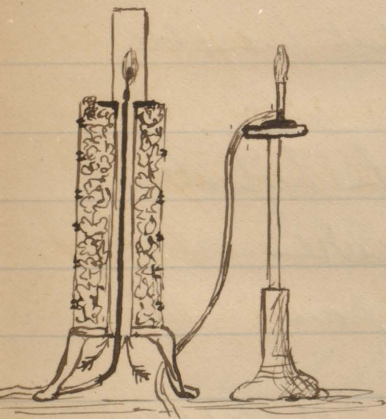
If a cylinder of lime be placed in this it gives scarcely any luminosity, but if the temperature of the flame be raised by passing oxygen into it, to about 5731°F the lime becomes intensely luminous. The same thing is true with Charcoal, It is also true with liquids, a drop of molten Platinum in the oxyhydrogen blowpipe flame gives an intense light. The same truth holds with gases & vapours. Thus

if the temperature of a flame is augmented the same amount of hydrocarbons, or even a less amount give more light, When a small quantity of pure O is introduced into the flame this is effected, & less gas gives the same amount of light.

The second method is to decrease the cooling surface of the flame, the greater the amount of gas burned at one flame, the smaller the quantity required to yield

the same light; the cooling surface is lessened & the hydrocarbons raised, consequently to a higher temperature.

The third method is to raise the temperature of the flame by previously heating the gases to enter into combustion. This may be well shown by passing a current of gas to be burned, & also the current of air, through a charcoal furnace, constructed as shown, & burning the heated air & gas in a chimney at the top.

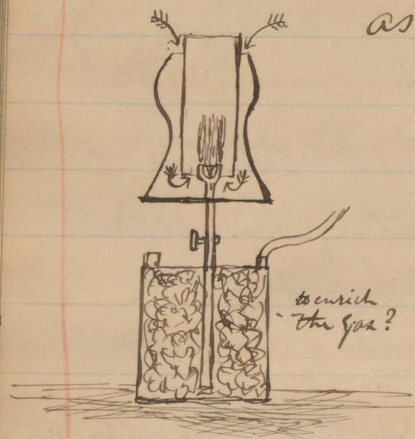


This experiment also well illustrates the 2nd ^{method} ~~experiment~~. Even

marsh-gas gives considerable light when burned from such an apparatus. This method

has been very successfully applied to use, by the construction of a lamp in which both the air & the gas are burned heated. The air becomes heated in passing between the two

glass shades, & heats the burner, & life as it passes up into the flame.



Shortly summarized
the conditions of greatest luminosity are.

1st The greatest amount of dense hydrocarbon vapours.

2nd The retention of these vapours for the longest possible time in the flame

3rd The production of the highest possible temperature.

4th Combustion under the highest degree of atmospheric pressure.

Table of Loss of light from
glass shades

Clear glass	12 per cent
Slightly ground in pattern	24 " "
Half ground	35 " "
All ground	40 " "
Opal glass	60 " "

Constituents of crude Coal gas

Imperatives

Sulphuretted hydrogen
Carbo~~sulphur~~~~ate~~
compounds
Ammonia

Carbonic anhydride
Carbonic disulphide.

Silicents

Hydrogen, Carbonic ^{acid?} oxide, Marsh gas.

Illuminants

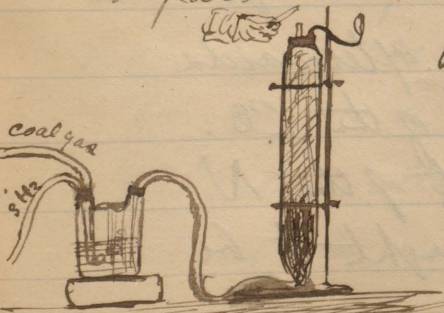
Blifant gas.

Buttine.

Propylene.

Acetylene.

The SH_2 is almost entirely removed by the processes employed in purification (passing through SH_2) Ferric hydrate). The experiment may be made as shown SH_2 & coal gas mixed, & passed through a cylinder, filled with



saw dust, & ferric hydrate, gradually blackens the hydrate but issues from the top quite pure, as shown by holding leaf paper in the current

CO₂ is never present in coal gas in large quantities, though often in gas made from wood to 20 to 25 per cent. No attempt is made to remove it from the coal gas. It however very greatly reduces the illuminating power. Every one per cent of CO₂ present reducing the light by 6 per cent. When the gas was passed through calcic hydrate it was much purer in this respect. It is a much worse impurity than air, for each volume of it gives up half its volume of O₂ & forms CO. Atmospheric air only contains 1/5 of its volume of O₂.

There is also an enormous diminution of temperature when CO₂ is changed into CO. It ~~is~~ equals that afterwards produced by the burning of the CO.

Ammonia is a product of the N present in coal. & ought to be

Carefully removed. There is a superstition among gas managers that if plenty NH_3 be allowed in the gas it will neutralize the SO_2 produced from the Combustion of the CS_2 .

This is quite erroneous as the NH_3 is completely decomposed. By act of parliament there ought not to be enough NH_3 in gas to brown moist turmeric paper when held in a current of it. This is always infringed.

The CS_2 & sulphur compounds present the greatest difficulty. Calcic hydrate removes much of these, but since the introduction of Ferric hydrate the gas has much deteriorated in this respect. Ferric hydrate is, so to speak a very weak sulphur base. The amount of S present in 100 Cubic feet of gas has increased from 4, 8, or 10, ~~to~~ grains, to 20, 30, or even 40. The amount of S is estimated by passing the gas mixed with air through a tube filled with ignited

Platinum gauze. The sulphur compounds
are decomposed & the Sulphuric acid
absorbed by soda-lime. (Invented by Valentini)

By another very good process the gas is
burned from a Leslie burner (the flame being
very low.) & the heated air & products of
combustion pass up, mixed with vapour
of Ammonia, from a small flask placed
near the flame. Into a receiver filled with
marbles. The water here condensing dissolves
the ammoniac sulphite & it rapidly oxidises
into Sulphate & drops, (in solution) into
a vessel below. It is then precipitated
by $BaCl_2$ dried & weighed.



Lecture XVII. March 1st 1870.

Properties of Diluents

One Cubic foot of H at 60°F & 30 inches

Barometric pressure. Consumes $\frac{1}{2}$ cubic foot
of O. Generates no CO_2 , & heats 1 pound 13 oz
of water from 32° to 212°F . Or 260 cubic
feet of air from 60° to 66.4° .

One Cubic foot of CO consumes $\frac{1}{2}$ cubic foot

of O generates 1 foot of CO_2 & heats 1 pound
14 oz of water from 32° to 212°F , or 2500
feet of air from 60° to 66.6°F

One Cubic foot of Marsh gas (CH_4)

consumes 2 Cubic feet of O generates
1 foot of CO_2 , & heats 5 pounds 14 oz. from
 32° to 212°F . or 2500 feet of air from
 60° to 80.8°F .

These diluents do not usually contribute
anything to the light. CH_4 however at very
high temperatures does so.

They indirectly, however allow more light to be obtained from the same amount of coal. They act as mediums for holding in suspension, carrying heavier hydrocarbons, which would otherwise be lost, as tar. If there is any choice this is to be preferred. The amount of illuminating hydrocarbons do not always show the true illuminating value of the gas, & therefore the determination of the value of gas by absorbing them by Bromine is not to be depended on. The value of the hydrocarbons in coal gas is much greater than in canal gas. Those in canal gas have probably a constitution analogous to olefiant gas (C_2H_4), while those in acetylene coal gas probably resemble acetylene (C_2H_2), & more readily give the dense hydrocarbons necessary to a strong illuminating effect.

As a rule, coals with the greatest percentage of H give the best gas. O does not seem to have so much influence.

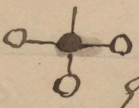
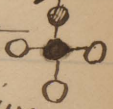
The production of good gas depends on many circumstances. The temperature of distillation is very important. The higher the temperature the more gas but it is poorer in quality. More is lost in illuminating effect than is gained in volume. At a very low temperature (curiously enough) the quality is also very inferior. Thus the gas produced in the manufacture of paraffin was proposed for illumination, but failed on this account.

It is also necessary to maintain as low a pressure as possible in the retorts, as the contact with the hot sides of the retorts quickly decompose the hydrocarbons. This is done by the exhaustor, & the pressure inside the retorts is not more than the atmospheric pressure outside. ~~The~~ Before its use the pressure, caused

by the obstruction of the Hydraulic main
7c, often amounted to 2, 3, or 4 feet
of ~~the~~ water.

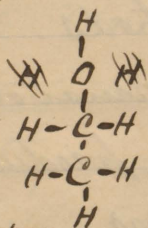
We have already considered the hydrides
of the positive radicals. And as we have
only assumed two negative radicals, there
are only two negative radicals. The hydride
of Cyanogen ($\{CN\}$) is Hcy , this we have
already considered. The hydride of Oxy ($\{CO \frac{1}{2}O\}$)
is $\begin{matrix} H \\ | \\ COHO \end{matrix}$ Formic acid. It belongs strictly
to the acids, & will be best considered
there.

The Alcohols

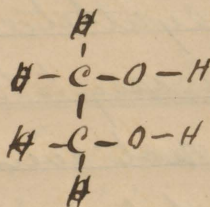
The alcohols are compounds of the positive
radicals with Hydroxyl. Thus methyl  forms methylic alcohol, or hydrate 
Each series of compound radicals gives
its own series of alcohols. The series formed
from the monad radicals, are called the
~~simple~~ monacid alcohols, because they are

capable of saturating one bond of molecule of
 a monad acid. Monohydrated alcohols is
 perhaps a better name. The Methyl series
 $C_n H_{2n+1}$ give alcohols of the formula of
 $C_n H_{2n+1} HO$.

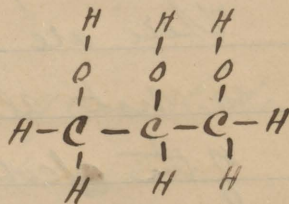
The Dyad radicals of course combine with
 two ~~the~~ molecules of HO , & form dyacid
 alcohols, also called glycols from the first
 discovered. The triads combine with three
 molecules of HO & form triacid alcohols, called
 also glycerols, from glycerine which is the
 only one known



Ethylie or common
 alcohol
 Monad



Dyad

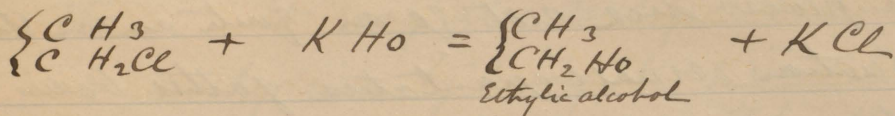
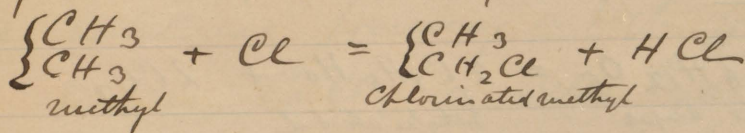


Glycerine
 Triad

The monacid alcohols are the most
 important, they are divided into three different

Classes, Corresponding to the normal, secondary, & tertiary radicals, where the C is united by 1, 2, or 3 bonds to other carbon atoms. If we separate the carbon atom to which the H is combined we at once find out to what class it belongs, whether a normal, secondary or tertiary alcohol. They ^{alcohols} have very ~~in~~ different properties. They are obtained by many processes, such as destructive distillation (methylic) fermentation (Ethylic) & secretion, (as melissic, & secreted in wax, & others). There are also synthetical methods. It is not always easy to trace the formation of the alcohol, not even in the production of common alcohol from grape sugar. If in an alcohol the H is replaced by H I & the iodide acted on by Zn , we get the monad radical. The alcohol may be conversely ~~by~~ prepared from the radical by

acting on its Chloride by potash. thus.



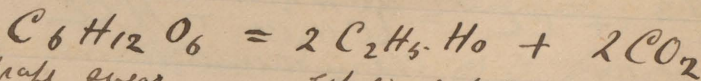
The dyad radicals may be obtained from their alcohols by the abstraction of Ho, & by an inverse process we may obtain the alcohols of the radicals.

Alcohols of the Methyl series stand, also, closely related to the hydrides. The monacid alcohols also stand in very interesting connection with Cyanogen.

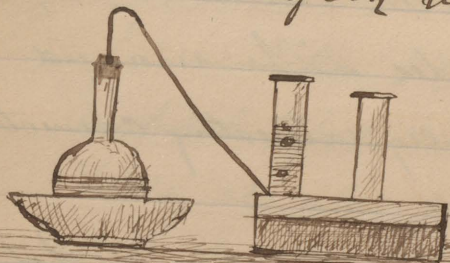
We will take as an example of an alcohol, Ethylic alcohol, (common alcohol, spirit, hydrated methyl) It was Maecus Praeus who first discovered that a spirit can be obtained from fermented liquors.

It may be obtained, 1st by the abstraction of water from ethylene.

2nd by the fermentation of grape sugar with yeast



The process does not go on quite as in the equation small quantities of other bodies are formed, such as propylic, amylic, & butylic alcohols. Most other sugars require to change first into grape sugar before the fermentation can take place. The process, & abundant evolution of CO_2 may be well shown, as below.



Ethyllic alcohol is manufactured on an enormous scale, it possesses a very powerful affinity for

water. If poorer liquids containing it are fractionally distilled by an apparatus still having a series of bulbous beads (as before shown) it may be obtained as strong as it is possible to obtain it by simple distillation at one operation. Absolute alcohol may

be obtained by digesting the spirit with some substance possessing a high affinity for H_2O such as CaCl_2 or Calcic hydrate, & rectifying from them. It may also readily be obtained almost anhydrous by tying it up in a common bladder, & exposing it to the air. The H_2O permeates the bladder, & evaporates from its surface, leaving the alcohol almost anhydrous. The strength of alcohol is easily found by its specific gravity, for which instruments are in use which do not even require reference to tables.

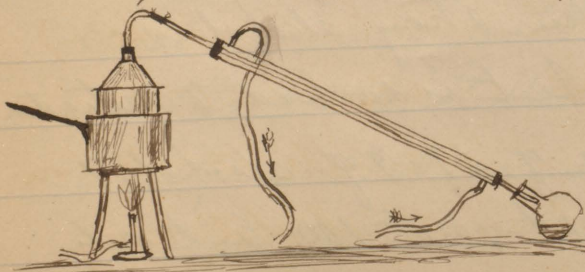
Lecture XVIII.

Wednesday March 2nd

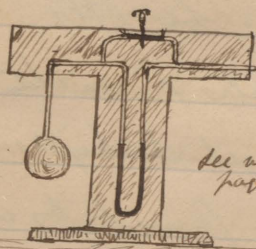
By distillation alcohol cannot be got more concentrated than about 93 per cent.

By digesting & distilling it from Calcic oxide (quick lime) it may be obtained absolute.

The most convenient apparatus is as shown



Alcohol ($\begin{matrix} C H_3 \\ C H_2 H O \end{matrix}$) is a colourless liquid, pungent, & mobile, & thus it is of great use in the manufacture of spirit-levels. (Its advantage over water in this respect may

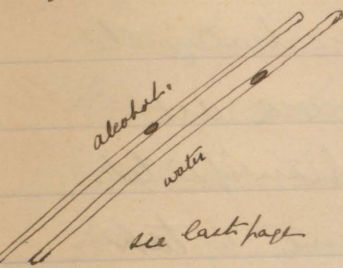


see next page.

be shown by, inclining two long tubes, of equal size one filled with alcohol, & the other with water, & containing bubbles of equal length. The air in the alcohol tube reaches the

top much the first.) It boils at $78.4^{\circ}C$ & has not yet been solidified. From this property it is used for filling thermometers for very low temperatures. Its indications below the freezing point of Hg are not to be very much depended on. Alcohol is inflammable, & has a great affinity for water, which it absorbs from the atmosphere. When strong alcohol is mixed with water heat is evolved, & contraction takes place. Thus if 57.3 g alcohol & 42.7 g water be mixed, not 100, but only

96.5 volumes of the mixture remain.



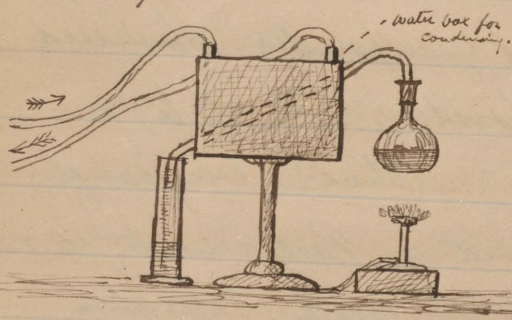
The evolution of heat may be plainly shown by immersing the bulb of an air thermometer in a beaker & then mixing the substances.

Alcohol abstracts O_2 from animal tissues, & coagulates albumen. It is probable that its poisonous effects, when concentrated, or injected into the blood depend on this property.

The duty on alcohol, is levied by a standard known as "proof spirit". Spirit below proof when placed on a heap of gunpowder & burned does not light the gunpowder, that of to, or over proof does so. This method is very rough.

Proof spirit is now defined by Parliament, as that which shall at $52^\circ F$ weigh $12\frac{1}{3}$ grains equal volume of water. Its composition is; H_2 50.76, O 49.24. Its specific gravity is .920 at $60^\circ F$. In liquors, which contain gum, sugar, &c it is impossible to

determine the strength by the specific gravity. Their additional weight quite neutralize the effect of the alcohol. Such liquors are distilled in an apparatus in principle like a Liebig condenser. The volume is taken at the beginning of the experiment, & when from $\frac{1}{2}$ to $\frac{2}{3}$ has passed over, containing all the alcohol, the distillate is filled up with distilled water, to the bulk of the original liquor, & the percentage of alcohol correctly ascertained by the hydrometer.



Many beverages are based on alcohol, mixed with many ingredients, & flavouring matters. Gin owes its flavour to juniper berries.

Rum from molasses. Whisky was originally made from malt which had been dried by heat, & was flavoured by the smoke. It is now flavoured by ethylic pelargonin, a peculiar oil, derived

for commercial purposes from oils & fats.

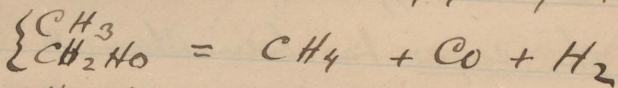
Brandy owes its flavour to that of wine & the grape
Arrac is derived from rice. In wines acids
such as tartaric, & acetic; sugar &c are generally
present. The same variety of grape give very
different wines, in different localities & countries.

When all the sugar has been changed into alcohol
by fermentation the wine is called dry, when
sugar is present fruity.

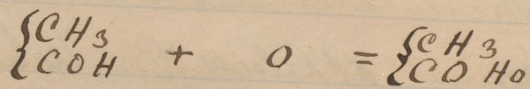
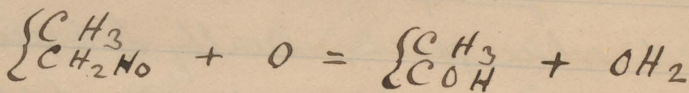
Alcohol dissolves gases, usually to a greater
extent than water. It is also a good solvent
for, oils, ^{especially essential} fats, resins, & Alkaloids &c. When it
is pure it does not oxidise in the air, but if
mixed with oxidisable substances changes to
 $\begin{cases} \text{C}_2\text{H}_5 \\ \text{CO}_2\text{H} \end{cases}$. Such change is especially likely to
take place when sugar is left, & hence the
souring of wines &c. In France glycerin is
now often used to sweeten beer instead of sugar.
The ^{beer} ~~wort~~ may be more completely fermented
& thus more got from the same malt. The

glycerine is not liable to ferment, & is also cheap, it being a waste product. Five tons of glycerine are thrown away from one extensive brewery, in London, every week.

Alcohol when passed through a white hot tube breaks up into CH_4 , CO , & H_2 .



By oxidation alcohol passes into aldehyde & then into acetic acid



When treated with acids alcohol yields salts (etherial salts). When distilled with Chloride of lime ethylic alcohol yields Chloroform.

Alcohol behaves somewhat like water, its constitution being analogous (OH_2 . $\text{O} \& \text{H}_2$) & sometimes combines with salts like water of crystallization, forming what are called alcoholates. The H of the Hydroxyl in alcohol can be

displaced by some very positive metals, as potassium or sodium, & ~~at~~ potassic or sodic ethylate formed.

It might be asked, then, why not class it among the acids, as it ~~is~~ holds displaceable hydrogen.?

It does not however belong to them, for in acids the hydrogen is displaced by oxides or hydrates, & this is not the case with alcohol.

The O in alcohol can be replaced by Sulphur & a sort of sulphur-alcohol formed. It is called mercaptan because of its great affinity for mercury.

Amylic Alcohol is always obtained in small quantities in the distillation of spirits. Especially if from corn, potatoes &c. An oily matter called fusel oil is left on the surface of the water.

It may be freed from common alcohol by washing with water (best saturated sol of salt.) It is then submitted to distillation, & the parts coming over below 135°C rejected. What comes over at a higher temperature is almost pure amylic alcohol. It is a colourless oily liquid.

with an unpleasant odour & burning acid taste. It inflames alone with difficulty, but burned from a wick gives considerable light.

It is soluble in alcohol ether & essential oils.

It yields by oxidation Valeric acid, homologous to acetic, which was produced in the same way from common alcohol.

Secondary alcohols contain only one atom of H in combination with the atom of C to which the Ho is attached. They yield ketones instead of acids when oxidised.

The Tertiary alcohols have no atom of H combined with the C atom with which the Ho is in combination. Only one (pseudobutyl alcohol) is known.

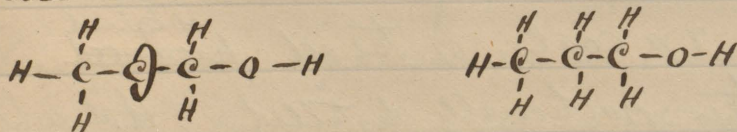
Lecture XIX. Thursday March 3rd

Vinyl or $C_n H_{2n+1} HO$ series. The normal alcohols only are known, & but two have been obtained. Vinyllic & Allylic alcohols.

Oil of garlic is allylic sulphate; & oil of Mustard allylic sulphocyanate; this is the exact analogue of Potassic sulphocyanate. As will be seen if the K be replaced by a molecule of allyl.

Acetylene stands in the same relation to Vinyllic alcohol as ethylene does to ethylic alcohol, & may hence be called the olifiant gas of Vinyllic alcohol.

By nascent H allylic may be converted into propylic alcohol, the two latent bonds are saturated with H. thus



Phenyl or $C_n H_{2n-7}$ series. Both normal & secondary acids of this series are known.

The secondary are the most important, they are Phenyllic alcohols, or carbolic (sometimes called)

Phenylic acid, & Cresylic alcohol.

Carbolic acid has recently come into great importance. It may be obtained from coal tar, it also occurs in the urine of man, the horse & other animals, It is also produced by the distillation of salicylic acid, & the destructive distillation of many organic bodies.

It may be also obtained by passing alcohol or acetic acid through a red hot tube. It may thus be formed from its elements.

It is manufactured from coal tar, on a large scale, mostly by Prof Hafford? at Manchester. Steam is first passed through the tar & the naphtha thus removed. The residue is then distilled, & a coal, or tar oil ~~produced~~ ^{obtained}. This oil is then fractionally distilled, & that which comes over between 150° to 200° Cent is kept apart. It contains almost all the carbolic acid. It is then thrown into a solution of caustic soda, containing lumps of undissolved soda.

The Carbolic acid unites with the soda & falls as a white crystalline substance. It is a molecular compound. The liquid is then decanted off. The residue when dissolved forms two layers, a light oily layer, & a heavy aqueous one, which contains the Carbolic acid. The aqueous portion is then neutralized with HCl , & the Carbolic acid (phenylic alcohol) rises to the surface nearly pure.

It is then digested on Calic Chloride, & distilled, which purifies it from water &c.

Phenylic alcohol is a white crystalline solid when first prepared, but afterwards changes to redish, & purple. It does not redden litmus. It unites molecularly with bases but does not exchange its hydrogen for the base. It requires 20 times its weight of water for its solution, but dissolves readily in alcohol. It is a powerful poison to plants & animals. It is a good preservative, & coagulates albumen. It also removes the offensive smell from putrid matters. The

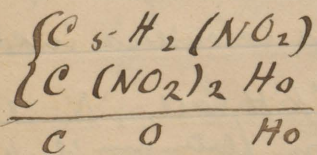
Preservation of meats &c by smoking depend upon the action of its analogue, creosylic alcohol or creosote, which is present in smoke. The so called salts of Carboic acid are soluble in water & crystalline.

With Cl , Br , & NO_2Ho it gives a large number of substitution products, & by these we gradually pass to the acids.

Picric acid ($\text{C}(\text{N}^{\text{O}_2})_3$
 $\text{C}(\text{C}_4\text{H})\text{H Ho}$) which is obtained by the action of nitric acid on phenylic alcohol is one of the most important of these. It may also be produced by the action of NO_2Ho & a great number of organic substances, such as, indigo, silk, resin &c. It is most readily obtained from carboic acid, with which NO_2Ho is mixed & the mixture first gently warmed & then heated. The picric acid should be dried at a low temperature, as otherwise there is danger of its explosion. It is soluble in O_2 , alcohol, & ether. When carefully heated it

fuses to an oily liquid, & resolidifies on cooling. If more suddenly heated it explodes with violence.

It is used in dyeing silk, wool & other animal fibres, though it has no affinity for cotton or vegetable substances. It gives a very bright colour especially if the material be mordanted with alum & Cream of tartar. It has an exceedingly bitter taste, & has been proposed for making beer bitter, instead of hops. Its tinctorial effect however is so great that its presence may be detected by the yellow colour of the froth. This is fortunate as it possesses poisonous properties. Its salts are usually yellow, & explosive. It is the first instance we have met with of an organic acid which does not depend for its acid properties on oxatyl, or cyanogen. The oxatyl may however be supposed to be replaced by the powerful acid principle NO_2 thus.



The oxatyl symbols below the line correspond to their representations above.

Cresylic alcohol, or Creosote has a close analogy with phenylic but has not been much studied.

Benzpic alcohol one of the normal alcohols of this series, is obtained by treating the oil of bitter almonds with alcoholic potash.

Dyad, dyacid, dyhydrate alcohols or glycols
General formula $\begin{cases} C_n H_{2n} H_0 \\ C_n H_{2n} H_0 \end{cases}$. Only four normal alcohols of this series are well known.

It is very curious, that, in this series as we increase the weight of the molecule the boiling point becomes lower. In general each addition of CH_2 raises the boiling point by about 18° . This fact has not yet been satisfactorily explained. These alcohols have ~~comparative~~ properties very similar to each other. The first in the series Glycol or ethylic glycol, is best prepared from the acetate of glycol. It is a colourless inodorous liquid; which dissolves OKH , $CaCl_2$, $NaCl$ &c. It is easily oxidised, when dropped on platinum black the temperature is raised to redness, & if the action be moderate glycolic, & then oxalic acid is formed.

Lecture XX.

March 4th 1870.

Triacid Alcohols. Of these only two are known Glycerine & amylglycerine.

Glycerine is the best known. It is present in almost all natural fats & oils, where it exists in combination with the fatty acids (acetic or oleic series) It saturates these acids, & in fact forms an ether or etherial salt. It may be liberated by water at a high temperature, or by bases which give insoluble salts with the fatty acids. By the last process the fatty acids fall as a curdy precipitate, which is identical with that seen, on washing in hard water.

Pasteur has shown that glycerine is also produced in the process of alcoholic fermentation.

Glycerine may be obtained pure in many ways. As by the action of plumbic oxide on oils. If 9 parts of olive oil be mixed with 5 of plumbic oxide, a glutinous substance, insoluble in water is formed, known as "Plaster" & used for that

purpose in medicine, & the glycerine is set free. H_2S is next passed through the liquid portion to precipitate the excess of alkali, the solution filtered, the water evaporated off, when pure glycerine is left.

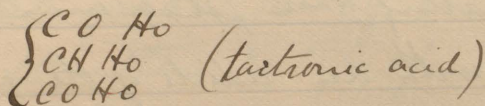
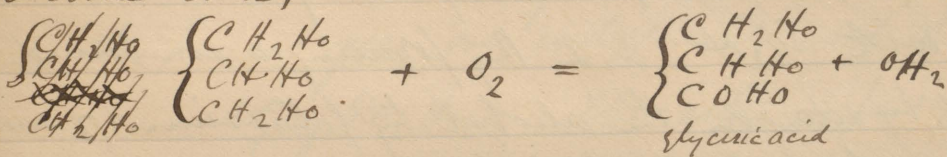
By another process, fat, oil, or tallow is boiled with milk of lime, which forms an insoluble soap & liberates the glycerin, which is evaporated down, & purified by distilling in a superheated current of steam.

It may also be obtained directly by passing currents of superheated steam thro' wetted oil, or tallow. The aqueous liquid being evaporated & distilled as before. It is passed through a still head kept rather above $100^{\circ}C$ so that all water remains uncondensed. The object of the manufacture is to obtain stearic acid & the glycerine is often thrown away.

Glycerin is a sweet, syrupy liquid, miscible in water & alcohol &c. At -20° It becomes

nearly solid. If heated quickly it distills but much decomposes toward the end of the operation. It is easily distilled in a current of superheated steam. It dissolves alkalies & alkaline earths, plumbic oxide, cupric sulphate &c.

By oxidation it passes into glyceric, & then tartaric acid,

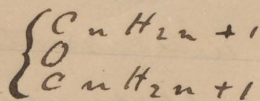


There are indications of alcohols of greater hydricity than trihydric. As the hydricity increases we gradually come to ethers which are probably alcohols.

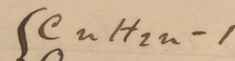
The Ethers

are compounds of the positive radicals with O, & analogues of potassic sodic &c oxides (ONa₂. OEt₂) Each series of radicals

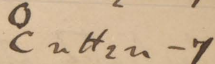
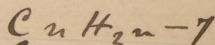
produces its own series of ethers, & thus there are three series, whose formulae are



methyl,



vinyl



phenyl series

There are two general processes for the ethers of the first group. 1 by acting on the alcohols with $SO_2 H_2$. 2 By forming a compound by acting on the alcohol by potassium or sodium, & then treating this potassium or sodium compound with an iodide of the same alcohol.

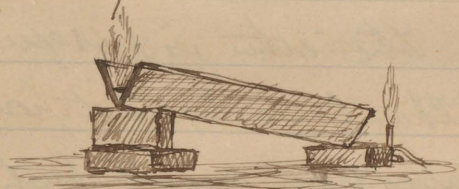
It is obvious that by this second process we may obtain two different radicals united into a compound ether by O. Such is the case, they are called double ethers.

Common alcohol $OEtH$ Ether OEt_2 , Et is substituted for Hydrogen. The ethers as a rule are more volatile than the alcohols from which they are derived, & less acted on by acids &c.

Ethylie, & common ether has been known since the fourteenth Century. It is prepared by heating equal volumes of alcohol & ~~ether~~ SO_2H_2 to from 140° to 145°C & then allowing more alcohol to drop in. Ether & water, which separate into two layers distill over. Sulphuric acid is at first formed, then decomposed by more alcohol, & reformed, & so the process goes on indefinitely with the same quantity of SO_2H_2 . The ether is purified by first agitating with milk of lime to free it from any acid. It is then rectified from a water bath, next ~~distilled~~ washed, with water saturated with salt to reduce its solvent power, & lastly placed over recently dried potassic carbonate to free it from water. It is a colourless, limpid, mobile liquid. Its specific gravity is .723, & is one of the lightest liquids known. At -31°Cent it crystallizes in brilliant needles. The vapour of ether is apt to cause explosions when mixed, with air in certain proportions, Its vapour

is much heavier than air, & by flowing along on the ground to some light flame, often lights the vessel of ether at some distance.

This may be well shown by placing a watch glass filled with ether at one end of an inclined trough, & a flame at the opposite extremity. The vapour flowing down takes fire & lights the ether in the watch glass. It mixes



with alcohol in all proportions.

It is an excellent solvent for many organic substances

specially such as contain much Hydrogen, as fats oils, resins. An ignited ^{coil of} platinum wire hung in a vessel, in which is a little ether continues to glow, by the slow combustion of the ether.

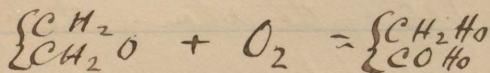
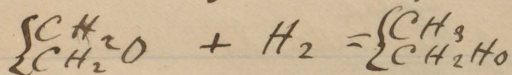
When ether is mixed gradually with its own volume of SO_2 , HO_2 sulphovinic acid. When exposed to air it changes to acetic acid, & is thus very difficult to keep pure.

Instead of being held together by O the ethyl may be held together by an atom of S^{II}, & forms an ethylic sulphide or sulphur ether. It is colourless & has an unpleasant odour of garlic.

The other monacid ethers are unimportant.

Lecture XXI. March 7th.
Monday.

Whelenic oxide, or ether, from the dyad radical ethylene. Is a gas but easily condensable to the liquid state. It is interesting on account of its easy change, to common alcohol by the action of nascent H, & to glycolic acid by the action of O.



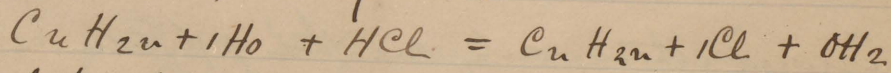
Triacid ethers, only one, that of glycerin is known.

Haloid ethers, may be termed the ethereal salts, & just as the alkalis form two series of salts, haloid,

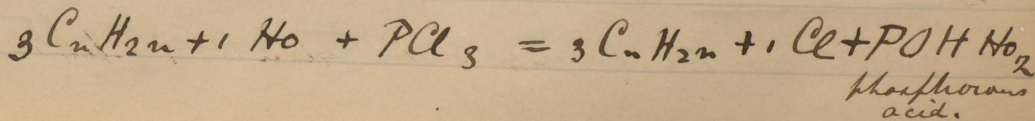
7 hydrosalts; so do these bodies, form compounds with Cl, Br, I, & C; & with acids, as oxalic &c.

The first of these series are called the series of haloid ethers, or ethereal salts. Each series of compound radicals forms its own series of haloid ethers, combined with Cl, Br, I, Cy, or Ph. The haloids of the unrad ethers are only capable of one form, the dyads are capable of two forms & the triads of four. In the first of these forms, two bonds remain saturated with Ho, in the second only one remains so saturated, & in the third all are replaced, in the fourth two bonds are saturated with an atom of O.

The haloid ethers of the ^{unrad} radicals may be obtained by several processes. 1st by the action of the hydricid on the corresponding alcohol.



2nd by the action of phosphorus trichloride on the alcohols.



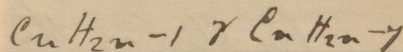
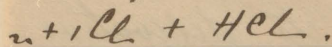
Ascent of alcohol series.

Aldehydes obt by distilling K salt
with K formate. (aldehyd & Carbonate)

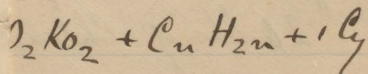
acted on by nascent H (from Na amalg)
get alcohol

alcohol converted into cyanide, &
acted on by OH H get K salt of next
highest acid.

hydrides of the radicals



production of the
must be done by
to distill in the
sulfate of the radical



reful & important of
easily yield their Iodine
ammonia the

the hydrides of
the; which when
old compound
atoms of H replaced
radical of the Iodide

ether. the above volume of the Iodide ether,
Methyl chloride &c are gases at ordinary temperatures.

7 salts; so do these bodies, form compounds
with Cl, Br, I, & C; & with acids, as oxalic &c.

The first of the

haloid ethers,

Compound of

haloid ethers,

The haloids of

are found,

the traces of,

two kinds are

second only

third all are

are saturated

The haloid

by several proc

on the concn

C_nH_{2n+1}

2nd by the

the alcohol

$3C_nH_{2n+1}$

17
116

100

(4)

4874.88720088
164

168 | 1474
 | 1344

1767 | 13089
 | 12369

17749 | 172072
 | 159741

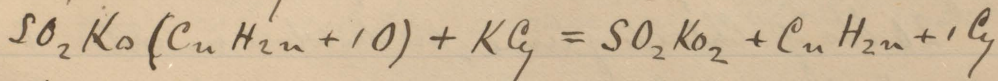
88
79

3rd By the action of Cl on the hydrides of the radicals



These reactions also apply to the $C_n H_{2n-1}$ & $C_n H_{2n-7}$ series of radicals.

These reactions do not apply to the production of the Cyanides of the radicals, this must be done by special processes, one of these is to distill in the dry state, a mixture of the Potassic Sulphate of the radical with Potassic cyanide.



The Iodides are the most useful & important of the haloid ethers, as they very easily yield their Iodine to any substance. With ammonia the haloid ethers behave exactly as the hydrides of inorganic Chemistry & form salts; which when treated with Potassic hydrate yield compound ammonias, with one of their atoms of H replaced by a molecule of the baseless radical of the haloid ether. The most volatile of the haloid ethers, Methyl chloride &c are gases at ordinary temperatures.

7 salts; so do these bodies, form compounds
with Cl, Br, I, & C; & with acids, as oxalic &c.

The first of these

haloid ethers, or

Compound radic

haloid ethers, con

The haloids of the

one form, the

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two bonds remain

second only one

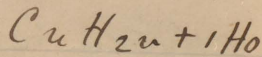
third all are refra

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The haloid ether

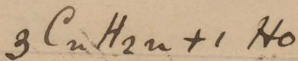
by several processes

on the correspond



2nd by the action

the alcohols.



3rd By the action of Cl on the hydrides of the radicals



These reactions also apply to the $C_n H_{2n-1}$ & $C_n H_{2n-2}$

Production of the
must be done by
to distill in the
sulfate of the radical

$\frac{1}{2} K_2 O_2 + C_n H_{2n+1} Cl$
eful & important of
sily yield their Iodine
ammonia the
the hydrides of
; which when
d compound
toms of H replaced
radical of the Iodide
Iodide ethers,
ordinary temperatures.

Methylic Chloride is interesting on account of its derivative Chloroform. If it be acted on by Cl_2 in the presence of light, monochlorinated methylic chloride is first produced, $\text{CH}_3\text{Cl} + \text{Cl} = \text{CH}_2\text{Cl}_2$. By carrying it on a step further trichlorinated methylic chloride, or Chloroform is produced CHCl_3 . By still further replacement CCl_4 may be obtained.

Chloroform is manufactured on the large scale from chloride of lime (bleaching powder) & alcohol.

20 lbs of Chloride of lime, are dissolved in water, & introduced into a coffee still, which must not be more than $\frac{2}{3}$ full in case of boiling over. 4 lbs of alcohol are then introduced & the mixture ~~gently~~ quickly heated to 80°Cent . When the action has begun the heat must be removed, as it generates sufficient itself. Two layers of liquid are found in the receiver the lower being the Chloroform. It is purified by washing with water, treating with dry CaO , & then distilling from dry CaCl_2 . When Chloroform is prepared from methylic alcohol the other

hydrocarbons &c which are formed, must be destroyed by distilling with $\text{SO}_2 + \text{H}_2\text{O}_2$.

Chloroform is a colourless mobile liquid, of sp. grav 1.48 boils at $60^\circ.8$ inflames with difficulty & burns with a green flame. It has an ethereal odour & sweetish taste. When pure, if it be agitated with water it remains clear, but when alcohol remains in it it becomes milky. ~~The presence of alcohol may~~ also be shown by mixing it with a solution of potassic bichromate & heating. The solution becomes green if alcohol is present.

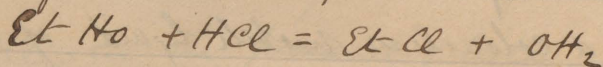
Chloroform is an excellent solvent for gums, resins, fats, oils, & ~~all~~ organic substances containing much C. It is the best solvent for gutta serena & when it evaporates leaves it unchanged. Bromoform & Iodoform are

perfectly similar substances. Chloroform heated with potassium after a time explodes with great violence.

Mixed with Cl & exposed to sunlight CCl_4 is formed

Ethyl chloride $\text{C}_2\text{H}_5\text{Cl}$, or EtCl is conveniently prepared by saturating alcohol with HCl , & distilling in a sealed tube at about 100°C for some

time, the liquid separates into two layers the lighter of which is ethylic chloride.



Ethylic iodide is of more importance, & may best be obtained by heating absolute ~~phosphorus~~ ^{alcohol}, ~~alcohol~~ & iodine in a retort. It is best to use red, or amorphous phosphorus as otherwise there is great danger of explosion, on the large scale.

The product is condensed in a Liebig's condenser. The ethylic iodide falls to the bottom of the receiver, & is coloured by free iodine. The proportions are 2 by weight of alcohol (99%) 5 of iodine & one of Phosphorus.

Tuesday March 8th.

Lecture XXII.

When pure, Ethylic iodide is a ~~pure~~ colourless ethereal liquid, with an ethereal odour, & a specific gravity almost twice that of water. It soon becomes coloured, however by the liberation of I, after a certain quantity has been liberated the action ceases, but if some means be

provided for the removal of the I, (as H_2 or Zn)
the decomposition continues, & by this process the
radicals, as before shown may be obtained.

The crude Ethylic Iodide, from the distillation should
be washed twice with its own volume of water,
to free it from alcohol, & agitated with H_2 to
remove the Iodine.

The Iodides of Methyl, & amyl, are very similar.

Methyllic iodide is one of the heaviest known liquids,
(with the exception of Hg) The rule seems to be that the
greater the percentage of Iodine the heavier the liquid

is. Ethylic bromide, may be prepared by
agitating Br_2 in a jar of ethylene (olefiant) gas.

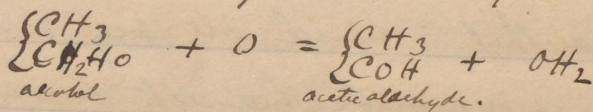
The Br_2 loses its colour & the ethylene is absorbed.

An oily liquid results, which has been called
Dutch liquid. Ethelic Cyanide may be prepared
by replacing the Br_2 in the ethylic bromide by
Cyanogen.

The haloid ethers of the triads are of little
importance.

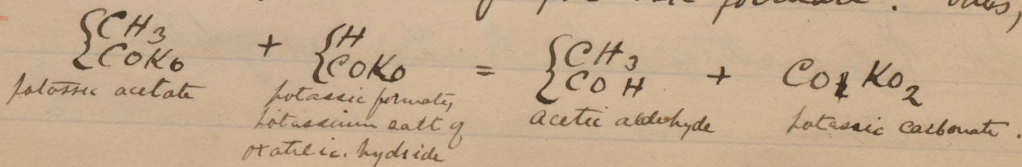
The Aldehydes this family of organic compounds is intermediate between the alcohols & the acids.

When a monacid alcohol passes by oxidation to an acid; there is, in all cases an intermediate body formed in which H is removed but not replaced. (The name aldehyde is from, alcohol dehydrogenatum). Thus ethylic alcohol yields acetic aldehyde.



The formula of the aldehydes may be written in two ways, thus $\begin{array}{c} \{ \text{CH}_3 \\ \text{COH} \end{array}$ or thus $\begin{array}{c} \{ \text{CH}_3 \\ \text{C}''\text{HO} \end{array}$ in the second Carbon is dyad. The question is what occurs do you really get C'' or does the C'' decompose the HO, & thus saturate its bonds. There is much evidence on both sides, but the C'' is most probable.

The aldehydes may be produced by oxidising agents as shown, or by distilling the potassium salt mixed with an equivalent of potassic formate. Thus,



The aldehydes are very important & interesting in
 synthetic chemistry, when acted on by nascent H
 alcohols are produced. Thus by the nascent H from
 sodium amalgam $\begin{matrix} \text{C}^{\text{H}_3} \\ \text{C}^{\text{O}}\text{H} \end{matrix} + \text{H}_2 = \begin{matrix} \text{C}^{\text{H}_3} \\ \text{C}^{\text{H}_2}\text{H}_2 \end{matrix}$. This is
 important as it forms a means of ascending the series
 of the fatty acids; for if the alcohol thus obtained be
 converted into a cyanide & treated with potassic
 hydrate, the potassic salt of the next higher acid
 is obtained. The aldehydes, spontaneously by the
 direct absorption of O pass into the corresponding
 acids, thus $\begin{matrix} \text{C}^{\text{H}_m} \\ \text{C}^{\text{O}}\text{H} \end{matrix} + \text{O} = \begin{matrix} \text{C}^{\text{H}_m} \\ \text{C}^{\text{O}}\text{H}_2 \end{matrix}$.
 When heated with potash the aldehydes give the
 potassium salts of the corresponding acids with
 evolution of H. Most aldehydes combine with
 Am & form crystalline salts, this rather places them
 in the ranks of the negatives. They also combine
 with the hydric, or acid sulphites of the alkalis, &
 produce crystalline compounds, they probably enter into
 the salt in a manner analogous to water of
 crystallization. This reaction is important as it

is by this means that we are enabled to
farify them.

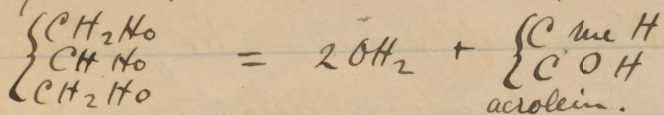
Acetic aldehyde is the most important, it is
usually prepared from alcohol, by acting on it with
the nascent O given off from SO_2 , H_2O_2 & Perm O_2 .

The mixture is put into a flask, & the distillate
must be condensed first by a Liebig's condenser
& then in a vessel placed in ice. The aldehydes
may also be obtained by the oxidising action of
Potassic bichromate &c, & by the action of oxidising
agents on Casein fibrin &c.

Acetic aldehyde is a colourless mobile liquid,
with a suffocating odour. It mixes with alcohol
in all proportions, & with water with evolution
of heat. It is capable of reducing Ag from its
salts, & has been proposed for silvering glass.

Best shown by filling a flask with solution of silver,
a little aldehyde, & a little ammonia, &
heating in a water bath. It has a tendency
to pass rapidly into isomeric modifications, metaldehyde
peraldehyde, claldehyde.

The aldehydes of the $C_n H_{2n-1}$ series have not been much studied, Acrylic aldehyde, or acrolein may be obtained by the action of phosphoric anhydride, or $SO_2 H_2$ on glycerin,



& by other processes. It is formed when the a tallow candle is blown out, from the snuff.

It is a colorless liquid, of intensely irritating odour & inflames the eyes.

The $C_n H_{2n-1}$ series also form similar aldehydes oil of bitter almonds is the aldehyde of Benzoic acid & gradually changes into that substance by absorption of O. It is also formed by the oxidation of Albumen, fibrin, casein, gelatin &c.

It is best prepared by digesting bitter almonds for 6 or 6 hours at about $30^\circ C$. The emulsion thus formed, is put into a flask & the oil distilled over by passing a current of steam. It cannot be obtained from sweet almonds for

though amygdalen is present there is no
synaptase in them. The synaptase is necessary
& acts as a ferment converting the amygdalen
into glucose, benzoic aldehyde, & hydrocyanic
acid. The poisonous properties of oil of bitter almonds
arises from the presence of HCN thus produced.

Lecture XVIII Wednesday March 9th.

The Acids form the great family of organic
bodies. Many of them exist ready formed in plants,
sometimes free, & sometimes combined with K
Na, Ca. Some acids also exist in animals, as
formic acid, in ants, & lactic acids in the juices
of the flesh. The basicity of organic acids may be
expressed by the law, that, An acid containing n
atoms of oxygⁿ is n basic. & this rule as thus
stated is without exception. On the basicity the
classification is founded, & the acids are divided
into three great groups, the monobasic, dibasic,
& tribasic.

The monobasic acids are subdivided into six series
1 Acetic, or fatty; 2 Acrylic or allic, 3 lactic, 4 pyruvic
5 Glyoxylic, 6 Benzoic or aromatic. All except
the fourth series correspond to alcohols, already studied.
The fourth & sixth series are called the monohydric,
or by some chemists the monatomic. The third
are dihydric, & the fifth trihydric. The H of the HO
of the acids is replaced by a metal when the
acid is brought in contact with its oxide, or hydrate.
But the atom of H outside the ~~hydroxyl~~ ~~oxetyl~~
cannot thus be replaced. Many chemists call
it the alcoholic hydrogen, as it behaves exactly
as the hydrogen of an alcohol.

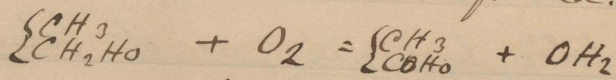
The acetic series of monobasic acids, is divided
into three sections, normal, secondary & tertiary.
In the normal the C which unites with the
oxetyl (COHO) must be united with at least
two atoms of H. In the secondary it is only
united with one, & n in the general formula
must have a positive value. In the tertiary all

the bonds are united with C.

The greater number of the acetic series are found in nature. Formic is found in ants, & nettles, cerotic in bees wax, Valeric in g_c

Also combined with glycerin & forming ethereal salts in almost all fats & oils. The acids may be formed

by the oxidation of the alcohols by $\text{SO}_2 \text{H}_2$ & MnO_2 , or $\text{SO}_2 \text{H}_2$ & potassic bichromate, thus if ^{alcohol} acid is introduced into a boiling mixture of $\text{SO}_2 \text{H}_2$ & potassic bichromate it becomes green from the reduction of chromic acid & acetic acid is formed.



2nd by boiling the cyanides of the radicals with acids or alkalis, NH_3 is given off when an alkali is used, or absorbed by the acid, if that be employed.

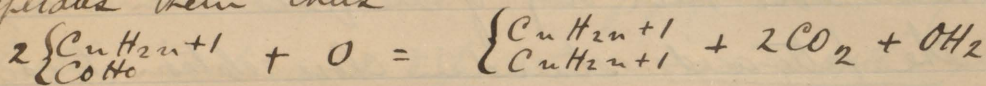
3rd directly from CO_2 . By the action of the sodium or potassium compounds of the radicals on CO_2

4th by the oxidation of the aldehydes.

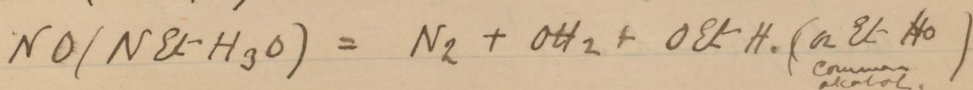
There are besides numerous special reactions for the various acids, such as the oxidation of casein,

fibrin, albumen, &c., & the production of acetic acid by the destructive distillation of wood.

The fatty or acetic acids are derived from the C_nH_{2n+1} series of radicals combined with CO_2 , nascent O separates them thus

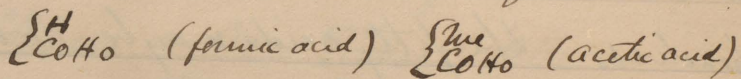


This is one of the very few instances known when the compound is separated at the carbon atoms. It seems in this case to depend on the almost complete differentiation which is caused by one carbon being combined with a very electronegative, & the other with electropositives. The fatty acids may be reconverted into the alcohols by Mendius's, & another, process. The cyanides are acted on by nascent H⁺ break up as shown in the equation, in a manner exactly analogous to Ammonic nitrate to which it is the exact analogue.

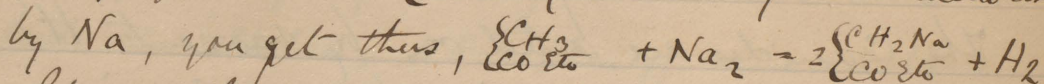


By the other process the aldehyde is produced by

distilling the potassic salt with potassic formate,
 By then acting on the aldehyde with
 nascent H the alcohol results. These
 reactions have been long looked forward to by
 Chemists but have only of late years been accomplished.
 The fatty acids stand in close relation to each
 other, & by replacement of H (beginning from
 acetic,) you may ascend the scale. If we
 could replace the H in formic acid by me, we
 could start from it, but though many attempts
 have been made this has not yet been done.



But if you act on $\begin{matrix} \text{CH}_3 \\ \text{COEtO} \end{matrix}$ (erroniously called acetic ether)



If now the sodium compound is acted on by the
 next highest iodide, & Na replaced by ~~Na~~
 we get acetic ethide. Two or three atoms of H
 may be replaced by Na, & secondary or tertiary
 acids formed.

Formic acid $\text{C}^{\text{H}}\text{O}_2\text{H}$, is the most simple of the acetic acid series. It exists in nature in ants, the stings of nettles, the hairs of some Calceolarias &c & is formed in many chemical operations. The most important mode of preparation is by heating oxalic acid & glycerin in an oil bath kept at 110°C . It may also be produced by an exceedingly interesting synthetical operation $\text{KH}_2 + \text{CO} = \text{C}^{\text{H}}\text{O}_2\text{K}$. It is produced by the oxidation of starch, & many other substances by SO_2 , H_2O_2 & KMnO_2 .

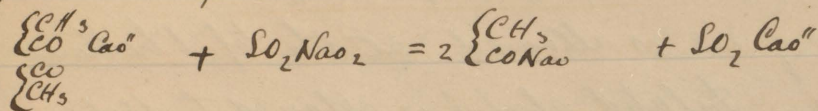
Formic acid, is a pungent, corrosive, volatile, liquid, which crystallizes at 0°C in long needles. Its vapour is inflammable. All its salts are soluble in H_2O , but ~~the~~ mercuric formate requires about 500 parts of water for its solution, & a few others of its metallic salts, are almost equally insoluble.

Lecture XXIV March 14th

Acetic acid occurs in nature in small quantities in some plants & in the juices of some animals. It is prepared in this country by making a sort of beer & allowing it to ferment or by the destructive distillation of wood, especially the harder varieties. Heat is gradually applied & finally raised to redness. Tarry matter, & an aqueous liquid which contains acetic acid, distill over. (The liquor which results from the distillation of coal is, as before shown, strongly alkaline)

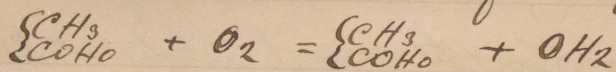
This liquid also contains methyl alcohol & various hydrocarbons. The acetic acid is neutralized with milk of lime, the liquid placed in large stills, & heat applied; when the methyl alcohol, & hydrocarbons pass over, & leave the calcic acetate in solution. The aqueous liquid containing the calcic acetate is then withdrawn, & evaporated to a syrup. A strong solution of sodic sulphate is then introduced, when sodic acetate, & calcis

sulphate are produced.



The sodic acetate is separated from the precipitate, evaporated to dryness, & carefully heated to a certain temperature, to destroy the last portions of the hydrocarbons. It is then mixed with enough dilute SO_2 & H_2 to decompose the salt, & heated in a still when concentrated $\begin{array}{l} \{ \text{CH}_3 \\ \text{CO} \\ \text{H}_2\text{O} \} \end{array}$ comes over. Anhydrous acetic acid may be obtained by forming acid potassium acetate, (which consists of the normal acetate combined with a molecule of acid) evaporating to dryness & heating to about 120° to 130° Cent, when this molecular compound breaks up & pure acetic acid comes over. The same quantity of potassic acetate may be used again & again. This process is much used in this country where a high duty is put on alcohol, on the Continent it is produced by the oxidation of alcohol. A tower 30 or 40 feet high is filled with shavings which should previously have been treated with infusion

of malt for some days or weeks. Free access of air is allowed at the top & bottom of the tower. Diluted alcohol is allowed to drip in at the top. The putrefaction ~~of~~ or fermentation of the wood is communicated to the alcohol, & is observed & it passes out a solution of vinegar



This is the final result, but it passes through the intermediate stage of aldehyde, this is almost gaseous at ordinary temperatures, thus it is necessary to oxidise as quickly as possible.

In this way dilute acid, of the strength of strong vinegar is produced, & is free from the pyroligneous flavour which is often present in wood vinegar.

In the beer process infusion of malt is allowed to ferment for some time at from 70° to 75° Cent in open casks. A large quantity of gelatinous Coniferous is produced, & is generally called mother of Vinegar. It is allowed by law to add $\frac{1}{1000}$ part of SO_2H_2 , which further acidifies it

It is supposed to prevent it from spoiling.

Acetic acid has a sharp aromatic taste, & an odour ^{somewhat} like formic acid. It crystallizes at 17°C . It attracts moisture very rapidly from the air. It is miscible with alcohol, & also with water, when up to a certain strength the density (specific gravity) augments, & thus it is impossible to estimate the strength of acetic acid by the hydrometer. The ~~maximum~~ greatest density corresponds to a molecular compound of acetic acid & O_2 . The density of acetic acid vapour is 2.12 & inflammable. It dissolves resins, gelatin, &c.

Exposed to sunlight with Cl , acetic acid gives a series of substitution products, in which 1, 2, & 3 atoms of hydrogen are replaced. The ^{general} formulae of its compounds are

$$\begin{array}{l} \text{C}^{\text{H}_3} \\ \text{CO}^{\text{H}_2} \\ \text{CO}^{\text{H}} \\ \text{C}^{\text{H}_3} \end{array}$$

Most of its compounds are soluble in alcohol & all in water. Acetic acid is used principally for three purposes. 1 As a condiment & antiseptic; 2 as aluminium acetate as a mordant. 3 with plumbic for giving the drying property to paints.

Propionic acid ($\begin{matrix} C_3H_6H_2 \\ \{CO_2H \end{matrix}$ or $\begin{matrix} C(CH_3)H_2 \\ \{COH \end{matrix}$) resembles acetic in most of its properties, all its salts are soluble in water.

Butyric acid occurs naturally in butter especially when rancid, in perspiration, the juices of flesh &c. It is best prepared, by mixing 16 grams of tartaric acid with 3 kilogrammes of sugar, & 13 kilogrammes of boiling water. This mixture is allowed to stand for some days, & then 120 g putrid cheese, in 4 kilos of milk & $1\frac{1}{2}$ of chalk is added. After about ten days the mass becomes almost solid from the production of Calcic lactate, this afterwards decomposes & the mass becomes fluid again. It is then mixed with water & sodic carbonate added, filtered, evaporated to a syrup, sufficient SO_2, H_2 added & distilled, the butyric acid comes over. It is believed that the ferment is in the chalk, for if it be previously heated to redness the action does not go on.

Valeric acid is a constituent of many plants as valerian & angelica root & it was formerly

obtained entirely from valerian roots. It is now prepared by acting on Amylic alcohol with oxidizing agents, exactly as in the transformation of alcohol to acetic acid. SO_2 , H_2O_2 & K_2O_5 - K_2O are boiled together in a retort of Amylic alcohol added drop by drop. Valeric acid has a peculiar & unpleasant odour which is very persistent. It is soluble in water & miscible with alcohol & ether.

Butyric acid is only capable of two modifications, the propyl in it may be either normal propyl, or isopropyl (β propyl) thus $\left\{ \begin{array}{l} \text{C Et H}_2 \\ \text{CO H}_2 \end{array} \right.$ & $\left\{ \begin{array}{l} \text{C } \text{iso} \text{ H} \\ \text{CO H}_2 \end{array} \right.$.

Normal Valeric acid ($\left\{ \begin{array}{l} \text{C } \text{Pr}_2 \text{ H}_2 \\ \text{CO H}_2 \end{array} \right.$) consists of a series molecule of normal butyl with a series molecule of acetyl. If the propyl be β propyl an isomer is formed which in all its properties closely resembles the normal Valeric acid. But they may be distinguished as one rotates the ray of polarized light. Two more modifications are possible.

Stearic acid is the principal constituent of ^{most} hard varieties of candles. Fat is composed of glycerine

Combined with stearic, oleic, palmitic & possibly
Myristic acid. There are several processes for
separating these acids from the glycerine. One by
running milk of lime into the melted fat, this
replaces the glycerine & forms an insoluble
salt, from which the glycerine may be washed. The
lime salt being then treated with SO_2 H_2O & steam,
The fatty acids are liberated, & Calcic sulphate formed.
The mixture of stearic & oleic acid thus obtained
is cast into cakes, interstratified with cocoa-nut
matting between every 5 or 6 layers a sheet of iron placed,
& the whole mass powerfully pressed. Most of
the oleic acid is thus got rid of. It is next
interstratified with fresh matting & ^{hollow} plates of iron
through which currents of hot water are passed; &
again powerfully pressed. Stearic acid is a
white crystalline solid soluble in alcohol & ether.

There are other processes for separating the acids from
the glycerine, by passing the fats mixed with water
through red hot tubes, & by passing superheated
steam through the melted fats.

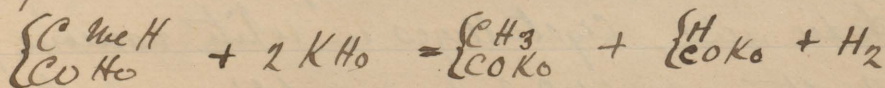
Lecture XXV. March 15th 1870.

The acrylic or oleic acids are related to the allylic alcohols, in the same way as the acetic series is related to the ethylic series. They exist ready formed in many fats oils &c. but only those of the normal series thus occur in nature.

Their general formula is $\begin{matrix} C(C_nH_{2n}) \\ \{COHo \end{matrix} (C_mH_{2m+1})$

m is always equal to nothing in the normal acids. The normal acids are produced by two processes. 1 By oxidation of the corresponding alcohols of the allylic & vinylic series. 2 by the oxidation of the aldehyde derived from the alcohol.

The acrylic acids stand in very close & interesting relation to the acetic series. If they are dropped on melted potash, two different ^{potassium} salts of the acetic series are produced. All the normal acids give potassic acetate as one of their products, thus acrylic acid, gives potassium acetate, & formate,

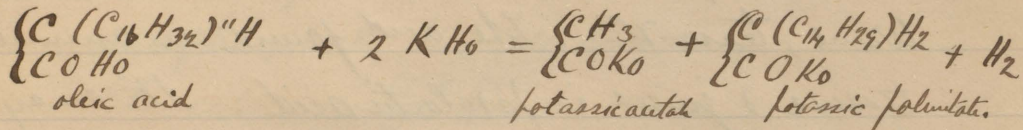


Acrylic acid is best prepared by the action (oxidising) of argentic oxide on acrolein.

Oleic acid is prepared in the purification of stearic acid. It may be purified by converting into the lead salt, dissolving in ether, crystallizing, converting into the barium salt, dissolving in water, crystallizing.

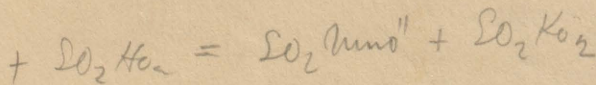
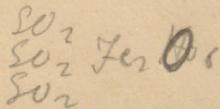
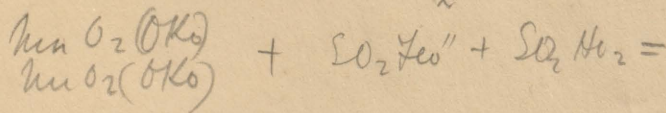
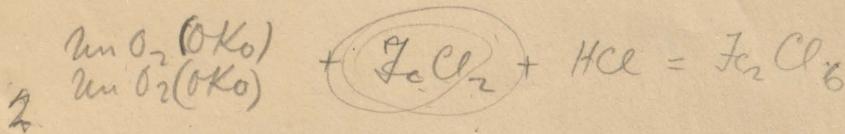
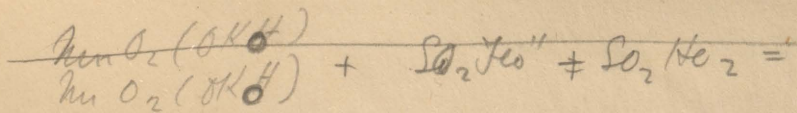
Oleic acid is insoluble in O_2 but very sol in alcohol & ether, it rapidly attracts O from the air becomes rancid & loses its property of crystallizing. It has a ~~of~~ suspended solidification, & melts at 4° Cent. By the action of nitrous anhydride? (allowed to bubble through them) oleic & apparently others of the series, pass into curious isomeric modifications, having quite different properties, thus oleic becomes white & crystalline. The nitrous anhydride ~~xx~~ does not seem to enter into any kind of combination with the acid. This isomer of oleic acid is called eladic acid, crystallizes in white waxy plates, melts at 45° Cent, & sublimes without change.

With potassic hydrate it gives precisely the same products as the normal oleic acid.



Mr. W. C. McDonald.

eries. It is convenient to
do into 8 classes, & though
some remain unknown, the
The general formula is



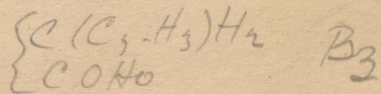
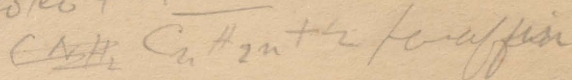
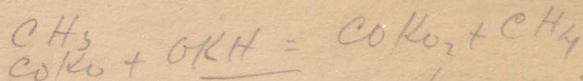
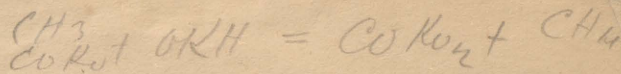
is the
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Acrylic acid is best prepared by the action (oxidising) of argentic oxide on acrolein.

Oleic acid is prepared in the purification of stearic acid. It may be purified by converting into the lead salt, dissolving in ether, crystallizing, converting into the barium salt dissolving in water, crystallizing.

Oleic acid is soluble in alcohol & ether becomes rancid.

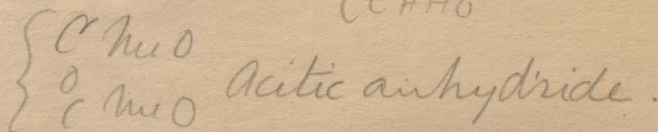
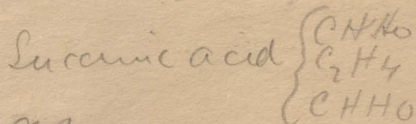
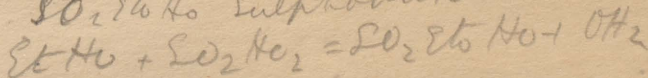
It has a Δ of 4° Cent. By (allowed to be) others of the modifications, oleic becomes ~~xx~~ does not with the acid eladic acid, melts at.



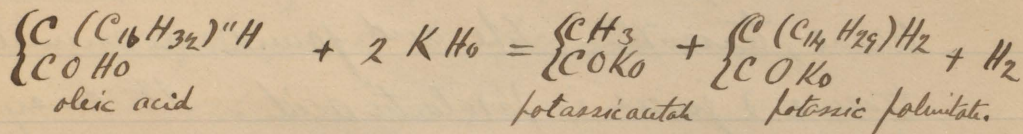
When acids act on and saturate alcohols they form ethereal salts.

C_6O_{12} #6 grape sugar

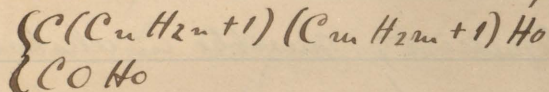
SO_2 #6 Sulphuric acid.



With potassic hydrate it gives precisely the same products as the normal oleic acid.



Glycolic or Lactic series. It is convenient to divide this series of acids into 8 classes, & though one or two of the divisions remain unknown, the acids no doubt exist. The general formula is



These acids are dihydric, but monobasic. In the normal series n may equal nothing but in the secondary it must be some positive integer

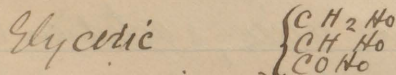
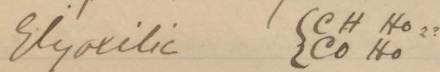
Classification

- 1 Normal acids
- 2 Etheric normal acids
- 3 Secondary acids
- 4 Etheric secondary acids
- 5 Normal olefine acids
- 6 Etheric normal olefine acids
- 7 Secondary olefine acids
- 8 Etheric secondary olefine acids.

Lactic acid occurs in sour milk, sauerkraut
muscular juices, gastric juices, saliva, blood
urine, tears &c. The acid found in animal
tissues & juices is paralactic acid. It may be
prepared by fermenting sugar with putrid cheese
just as in the production of Butyric acid, but
the fermentation is not allowed to go so far.
It must be purified by many crystallizations,
& processes. Lactic acid is a colourless syrupy liquid,
inodorous, deliquescent, miscible in alcohol & water.
It is produced in the souring of milk from the
transformations of the milk sugar. The stomachs
of various animals which feed on milk have the property
of inducing this change to take place. Casein being
soluble in an ^{alkaline} ~~acid~~, but not in an acid solution
is precipitated on the addition formation of the lactic
acid & a curd formed. (Milk being naturally alkaline)
The stomach of the calf is preserved & used in this
way in the manufacturing cheese. Lactic acid also
coagulates albumen. All its salts are soluble
in water, that of Zn least so.

Lecture XXVI March 16th 1870

Glycolic series of acids, these have been but little investigated, only two are known,

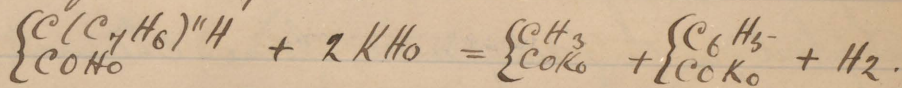


this constitution is a disputed point. The two half molecules of H_2O are very apt to pass out of the acid by heat, in the form of water, some chemists maintain that it is really water molecularly combined. They are derived from the trihydric alcohols.

Benzoic, or aromatic series of acids, stands in exactly the same relation to the Benzoic alcohols, as the acetic series bears to the ethylic alcohols. A semi-molecule of the alcohol combined with a semi-molecule of acetyl.

Four acids are known, Phenolic, collinic, Benzoic, Toluylic, Cumicic. The general formula is $\begin{cases} \text{C} (\text{C}_n \text{H}_{2n-7}) \text{H}_2 \\ \text{CO} \text{H} \text{O} \end{cases}$ which is exactly analogous to the acetic series, but contains the $\text{C}_n \text{H}_{2n-7}$ radicals. They have been but little studied, but there is no doubt, but that they form the start point of other series, which

will stand in the same relation to them, as the acrylic, glycolic, pyruvic, & glyoxylic bear to the acetic series. Cinnamic acid must stand in the relation of an acriloid acid to ~~some~~ ^{an} unknown homologue of the Benzoic series, & acted on by caustic potash it undergoes a change precisely analogous to that of the acrylic acids.



Thus also, Salicylic acid is the lactic acid of benzoic acid (being a monobasic dihydric acid).

Oil of Meadow sweet is the aldehyde of salicylic acid, thus $\left\{ \begin{array}{l} C(C_5H_3)H_2O \\ COH_0 \end{array} \right.$.

Benzoic acid, was known formerly as flowers of benzoin. It exists ready formed in gum benzoin, & may be obtained by careful heating, it exists in Scorpions blood, balsam of tolu, in urine & many gums & balsams. It may be obtained as a sublimate by heating the gum benzoin,

It may also prepared by the oxidation of oil of bitter almonds. Also by the oxidation of casein, gelatin, &c.

And by the action of HCl on the peccollic acid (hippuric) found in the urine of the horse & cow, Benzpic acid & a substance called glycosin result. It is often manufactured in this way, & may be distinguished from that manufactured from the gum, by the want of its aromatic odour. It crystallizes in needles or flat diaphanous plates, when pure it has no odour, it has a pungent & acid taste, reddens litmus, sublimes at 135° Cent, & is soluble in alcohol & ether but sparingly in water. It is used as a perfume &c.

Sibanic acids

These acids contain two semi-molecules of acetyl & may be looked upon as the dehydrations of the dihydric alcohols. By dehydrating bodies & sometimes by the action of heat alone they loose ~~water~~ hydrog., in the form of water, the residual oxygen satisfying the bonds, & become anhydrides. When the anhydrides are treated with Phosphoric chloride, the O is

replaced by two of Cl. Both the anhydrides & the chlorides, by the action of water yield the original acids. Many of these acids are produced by the oxidation of substances richer in C than themselves, such as fats, oils, &c., Succinic from amber. Four series are known, & there will be six corresponding to those of the monobasic acids.

Succinic or Acetoid series.

Succinic acid, exists in amber, also in lignite, the resin of several pines, & in many vegetable & some animal substances.

For practical purposes it is obtained by the distillation of amber, or the fermentation of Calcium malate. It resists oxidation very powerfully & is thus often left as the residue of the oxidation of fats resins &c. Boiling NO_2H_2 or hot chromic acid (CrO_2H_2) have no effect on it. It is oxidised however by boiling SO_2H_2 & KMnO_2 . It has two isomeric modifications.

Lecture XXVII. Monday March 21.

Tartaric or glycolic acid series.

Tartaric acid, is peculiar for its curious isomerisms, there are four or perhaps even a fifth variety.

Dextro-tartaric acid,

Laevotartaric acid.

Racemic acid

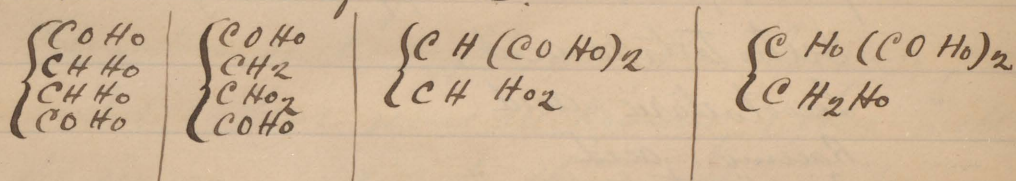
Inactive tartaric acid

Metatartaric acid.

They are distinguished by their different action on a ray of polarized light. Dextro-tartaric, or ordinary tartaric acid, rotates the ray to the right, or in the direction of the motion of the hands of a watch, when it is passed through its solution. Laevotartaric turns it in the opposite direction. Racemic has no action on the ray & has been proved by Pasteur to be a molecular compound of equal quantities of the dextro, & laevo tartaric acids, which may be resolved into its constituent acids, & afterwards reformed from them.

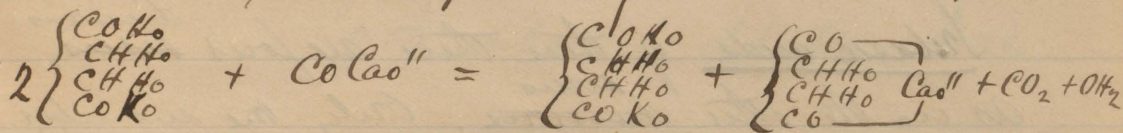
Inactive tartaric acid like the racemic acid does not affect the light, but it cannot be resolved

into ^{the} other acids. Metatairic acid may be only inactive tartaric acid. It will be seen that the formula of tartaric acid is capable of four isomeric modifications.



By the action of Hydriodic acid tartaric acid is converted into Succinic acid. The HI, being used as in so many cases to take out the Ho & replace it by H. The first pair of acids (as above) produce normal succinic acid. The last two ought to yield isosuccinic. This has however never been successfully carried out. Normal succinic acid results from all four, this fact seems adverse to this view of the isomerism. A slight degree of heat however seems to transform the acids into one another. The chief source of diastartaric acid is "argol" or the residue which is found in casks &c in which wine has been fermented.

it consists of an acid tartarate of Potash. Tartaric acid however is very frequently met with in the vegetable kingdom, often free. It is prepared from the acid potassic tartarate by two consecutive processes. The solution is boiled & finely powdered Chalk added, when the following reaction takes place



The calcic tartarate which is insoluble is collected on a filter, & the remainder of the potassic tartarate then decomposed by the addition of CaCl_2 . Had CaCl_2 been added in the first instance ^{the precipitate} it would have dissolved some of the Calcic tartarate.

The Calcic tartarate thus obtained is decomposed by dilute SO_2H_2 the solution filtered, & evaporated.

Tartaric acid crystallizes in colourless prisms soluble in water & alcohol but not in ether.

It precipitates lime water but not basic chloride.

Tartaric & Racemic acids differ besides their different action on light, by ~~these~~ the different solubility of

their Calcium salts; the Manganic salt being insoluble. By very gentle oxidation tartaric acid yields tartaric, & when more violently oxidised formic acid. Heated with fused K_2O it gives, potassic acetate & tartarate?

Tribasic acids of these there are four ^{divisions} ~~series~~, as in the other ~~divisions~~ ^{series}. Only one member of each division is known. Citric acid is the acid in this series corresponding to lactic acid in the Acetic series.

Citric acid is found free in many fruits as, gooseberries, raspberries, cherries &c. It forms rhombohedral prisms, possessed of a very acid taste. It is used in calico printing though not so largely as tartaric acid. It is soluble in alcohol & OH_2 but not in ether. It dissolves Zn & Fe with evolution of H .

Anhydrides. The anhydrides are compounds formed from the acids by the abstraction of all the hydroxyl. The residual O satisfying the free bonds. They may be divided into.

- 1 Anhydrides of the monobasic monohydric acids.
- 2 " of the monobasic dihydric acids
- 3 " of the dibasic dihydric acids.

The Ketones are very closely ~~are~~ related to the aldehydes. They are aldehydes, in which the H of the negative radical has been replaced by a monad alcohol radical. They may also be looked upon as derived from the acetic series of acids by the substitution of their hydroxyl by a monad radical. They may also be correctly viewed as compounds of carbonic oxide with the monad alcohol radicals.

The Ketones do not oxidise spontaneously like the aldehydes. By the action of nascent H they give alcohols.

Tuesday March 22, 1890.

Lecture XXVIII.

The ethereal salts are a very numerous class.

They correspond exactly with the salts of the negative organic radicals, ^{or acids} with the metals. Their formation is exactly the same. But as the alcohols not being as strongly basic, as the metals it is advisable to bring them the acid & the alcohol together in the nascent state.

Monobasic acids form only one ethereal salt with one ~~monobasic acid~~ ^{acid} alcohol. With a triacid alcohol it can form three, with a triacid, three. Dibasic acids, with unacid alcohols can form, normal & acid ethereal salts.

Ethilic acetate (Acetic ether). For the preparation of this substance, 6 kilograms of dried, fused, sodic acetate are placed in a copper still, surrounded with cold water. 12.6 kilo of a mixture of 9.6 kilo of strong alcohol & 9 kilo of SO_2H_2 are then added & the mixture allowed to stand for 12 hours

(The alcohol & SO_2, H_2 are best mixed by passing the alcohol into an earthen dish filled with SO_2, H_2 by a glass tube; from the bottom.) The vapour is then distilled & the vapour passed through a Liebig condenser. The distillate should be washed with OH_2 , placed over CaCl_2 to remove the water, poured off & redistilled.

Electric ether is a colourless transparent liquid, of an agreeable odour soluble in 7 of water, & miscible in all proportions in alcohol & ether. It suffers rapid decomposition in presence of water.

The acid ~~di~~^{ethereal} salts of dibasic acids are usually regarded as peculiar acids.

Organic Compounds containing triad & pentad N.

May be divided into two great groups, 1 compounds containing triad N, 2 compounds containing pentad N.

The bodies containing N''' may be further subdivided into basic, neutral, & acid series

<u>Basic</u>	<u>Neutral</u>	<u>Acid</u>
1 Amines	1 Amides	1 Imides
2 Phosphines	2 Alkalimides	7 Nitrides.
3 Arsines	3 Trichlorinated & trichlorinated amines	
4 Stibines	4 Haloid compounds of oxybases	
5 Oxybases		

The Amines & Amides are the only two important classes.

The Amines are of four kinds, Monamines, diamines, triamines, tetramines.

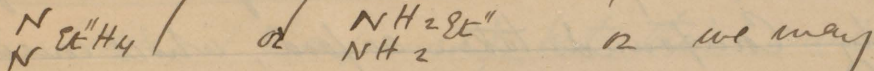
The Monamines are further divided into primary, secondary, & tertiary, in which 1, 2, or 3 of N has been replaced by an organic radical.

The Primary Monamines, may be considered as ammonias in which one atom of H has been removed & replaced by one molecule of an organic radical.

The Secondary Monamines are produced by the still further action of the residue of the radical, two atoms of ~~an~~ H being replaced.

Tertiary Monamines, may be formed containing several different radicals, (mixed tertiary monamines)

The Diamines are formed by coupling together two ammonias by a dyad radical, thus



obviously look upon them as compounds of amidogen (NH_2) with Et'' . The Diamines are ^{also} divided into primary, secondary, & tertiary series, in which 1, 2, or all three atoms of H have been replaced. They are only of special interest because they contain Urea.

In Urea the two molecules of amidogen are joined by Carbonyl (Carbonic oxide) thus $\begin{array}{c} \text{NH}_2 \\ | \\ \text{NH}_2 \end{array} \text{CO}''$.

Urea is produced in animals, & is the final result of their action on nitrogenised food. It may also be easily produced synthetically by evaporating ammoniac cyanide to dryness. A rearrangement of elements takes place thus $\text{CN}''(\text{NH}_4\text{O}) = \begin{cases} \text{NH}_2 \\ \text{CO}'' \\ \text{NH}_2 \end{cases}$.

Many other ureas may be produced containing one or more of these organic radicals in place of many atoms of H, only one however is produced in nature. Urea was first noticed in 1773, it is found in the excrement of all animals, reptiles,

of birds. It is due chiefly to the oxidation of food, partly also to oxidation of the tissues of the body. Compounds taken as food, which consist of C & H escape as H_2 & CO_2 ; but N cannot be thus completely oxidised it passes out as urea which still contains much unconsumed force.

If urine be evaporated to $1/10$ & strong NO_2 be added Urea separates in large quantity.

It is however most conveniently prepared by the synthetical process. 28 parts of K_4FeC_6 & 14 of MnO_2 are heated till they begin to burn on an iron plate. Potassic cyanate is produced. This is dissolved in cold water & 20.5 parts of ammoniac sulphate added. On evaporation most of the potassic sulphate crystallizes out, the residue is evaporated to dryness, & is immediately transformed to urea. This may be dissolved out by alcohol & crystallized.

Urea may also be produced by heating CO Am oz in a sealed tube, strongly



Lecture XXIX.

Wednesday March 23 1870.

The Vegetable alkaloids, are included among these bodies, (Ncompounds) but their constitution is not known. Some of the principal of these are those contained in opium, they are, Morphine, Codeine, Thebaine, Papaverine, Narcotine, & Narceine. Morphine is the most important, It has been known, in an impure state for a long time.

It is prepared as follows, Opium is macerated with Cold water, strained, & the liquid evaporated to a syrup, While still hot a great excess of CO_2NaOH is added, as long as NH_3 is evolved. It is then allowed to stand for some time, collected on a filter & washed, Treated with alcohol, of sp. grav. 1.15. Acetic acid is then added, & the acetate passed several times through animal charcoal to decolorize it. Ammonia is then added which throws down the alkaloid.

Gumma opium usually contains from 10 to 15% of Morphin. Its salts are generally easily Crystallizable.

Chinchona bark owes its febrifuge properties to the presence of quinine & its allies Chinchonine & aricine &c. The grey, yellow, red, & white barks contain them in different proportions. Quinine was first obtained by Pelletier in 1840. The tree from which the bark is obtained is small & requires to be 5 years old before it is barked. The trees used formerly to be destroyed in this operation, but now only a strip of bark an inch or two wide is taken off at a time, the place is covered with moss & allowed to grow over, when it yields a bark containing a much larger percentage of quinine. It is extracted from the bark by ~~the~~ dilute SO_2 , precipitated with lime & purified by several processes. Quinine gives a green colour, if Cl water & then a little ammonia are added to its solution. The quinine of commerce is usually contaminated with 2 or 3 percent of

Cinchonine, which is almost useless as a
febrifuge; this amount however is allowable
as it is very hard entirely to separate them. Its presence
& to some degree its quantity is easily found as
follows. Put ~~one~~ ^{grm} of quinine in a test
tube, add 12 ~~grms~~ ^{grm} of washed ether, & then 1 or 2 grm
of caustic ammonia. The fluid separates into two
layers the ethereal contains the quinine in
solution, & the aqueous, ammoniac sulphate. If
Cinchonine is present a milky layer forms
between the two strata of liquid. Quinine &
Cinchonine also differ by their action on polarized
light, Quinine rotates the ray to the left,
Cinchonine powerfully to the right.

Narcotine the active principle of tobacco, in which
it is probably combined with citric or malic acid.
In ~~quantity~~ ^{quantity} it varies from $\frac{3}{4}$ grm, to 4 or 5
percent. It is one of the few fluid alkaloids.

Strichnine & Brucine from *nux Vomica*.

Strichnine gives a very beautiful violet colour

when treated with strong oxidising agents, & may thus be detected. Thus if strichnine & $\text{SO}_2 \text{H}_2$ be spread upon a plate & a crystal of $\text{CrO}_3 \text{H}_2$ ~~is~~ be added the purple tint is obtained.

The Phosphines Arsenes & Stibines, are ammonias containing As, Sb, & P, & may be looked upon as derived from phosphuretted antimonuretted & arsenuretted hydrogen. They have however, never been thus prepared.

Thursday March 24th 1870.

Lecture. XXX

Compounds of N^v & its analogues.

The caustic nitrogen bases, are compounds of hydrogen with ammonias containing positive radicals, & are exactly analogous to the hydrous oxide of ammonia, which should be written thus $\text{N}^{\text{H}_4} \text{H}_5 \text{O} = \text{NH}_4 \text{HO} = \text{AmHO}$.

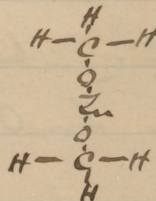
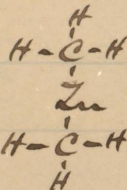
The Caustic Sb, As, & P, bases have exactly analogous constitution.

The Organometallic bodies, differ from other radicals containing a metal, by the metal being linked directly with their Carbon.

Zinc ethide is organometalloid $Zn Et_2$

Zinc ethylate not so $Zn EtO_2$

Of these with, Zinc methide & methylate



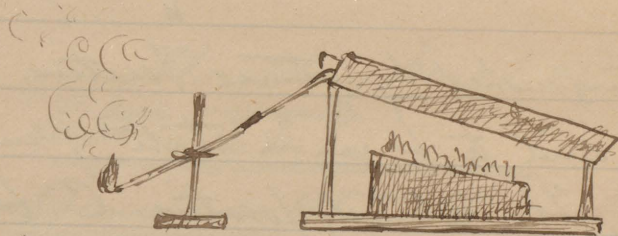
They are distinguished by intense positive energy. They may be said to be in a state of unstable equilibrium, the intensely positive C being united with the very positive metals.

They are produced in a large number of chemical reactions.

1 by the union of positive unoxid radicals in the nascent state with a metal, or

by the action of their iodides on a metal.

Thus by the action of Zn on EtI the radical is liberated & the zinc ethide at the same time formed (as before shown) If the smallest quantity of radical is wanted & the most possible Zn Et₂ a quantity of ether is also put into the tube. If such a tube (after having been properly dipped) is broken off & gently heated the ether at first passes over & then the Zn Et₂ which burns with a bright flame & deposits ZnO.



2 By the action of metals alloyed with potassium or sodium on the monad positive radicals.

3 By the action of the Zn compounds of the monad positive radicals on the haloid

Compounds of the metals themselves or their
organic derivatives

4 By the displacement of a metal in an
organometalloid body by another more positive.

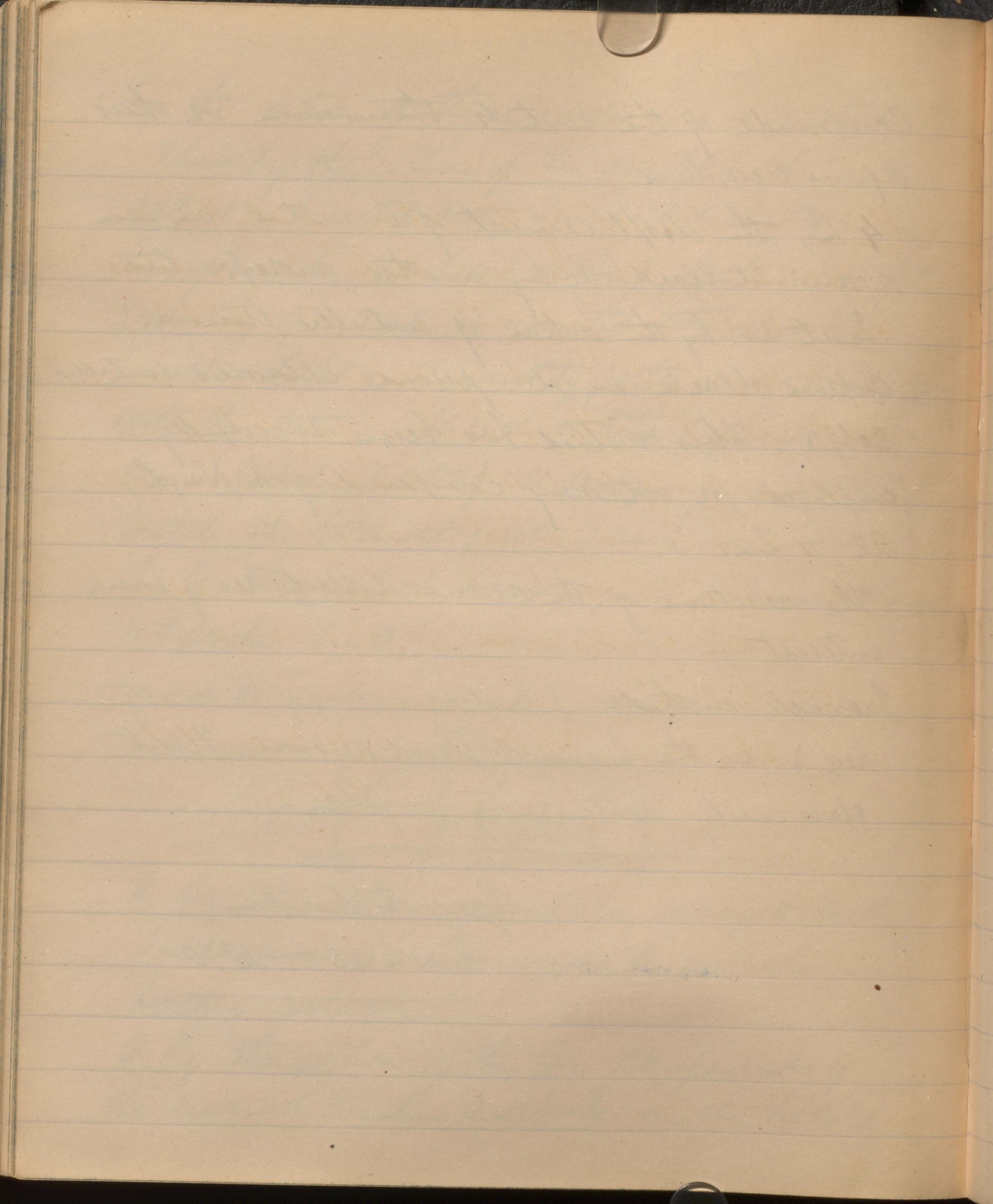
Just as by the action of metallic iron on
cuprous chloride we get ferrous chloride & metallic
copper. This method has been successfully
employed for obtaining compounds of K, Na, L,
Al, & Zn.

The reactions of the organometalloids are of some
interest

Mercuric methide (unless a comp of $\frac{1}{2}$ recently
prep) is the heaviest fluid known. It
easily floats on its surface.

George M. Dawson

March 26 - 1870



HCl is obtained by the action of $\text{SO}_2 \text{H}_2\text{O}_2$ on NaCl . On the large scale two or more tons of NaCl are put into a retort, sealed up - & $\text{SO}_2 \text{H}_2\text{O}_2$ introduced by means of a funnel. Heat applied, & the resulting gas led off into a series of Wolff's bottles made of earthen ware or towers lined with coke & there condensed.

The reaction sought to be produced is

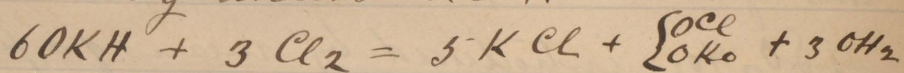


but often is

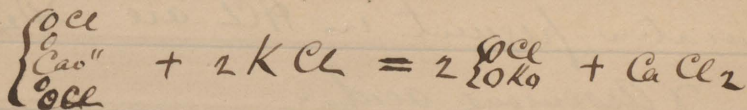
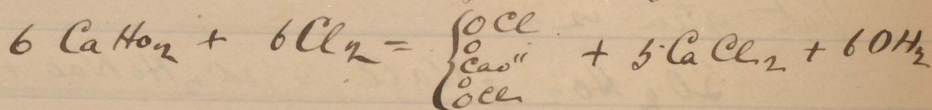


The impurities frequent in HCl are $\text{SO}_2 \text{H}_2\text{O}_2$, Fe_2Cl_3 & Arsenious acid.

$\left\{ \begin{array}{l} \text{OCl} \\ \text{OKo} \end{array} \right.$ used in dying Calico-printing,
 pyrotechny &c. Was formerly prepared by
 passing Cl through OKH. By this process
 however ~~5/6~~^{5/6} of the K is changed into the
 comparatively useless KCl.

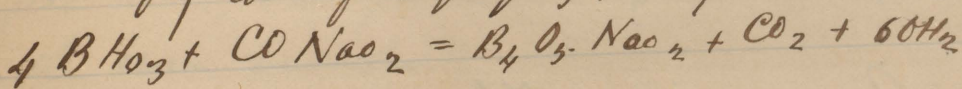


The mixed chloride & chlorates of Calcium are
 now in the first place produced by passing
 Cl through milk of lime ^{kept nearly at the boiling point.} Crystallising out
 the useless chloride & replacing each atom
 of Ca in the compound by two of K



Borax ($B_4O_5 \cdot Na_{10}O_{22}$) is usually prepared from the boric acid obtained from the Tuscan lagoons. The steam bearing it in solution is condensed in tanks of water. Which is ~~also~~ afterwards evaporated down by the same agency. The acid is then dried in chambers heated by steam & packed. To convert it into borax, about $1/2$ a ton of sodic carbonate is dissolved in water & an equivalent of boric acid added. A quantity of ammonia is evolved which is collected by passing it through $SO_2 \cdot HO_2$.

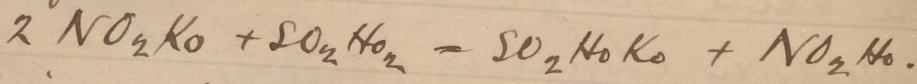
Chiefly used for glazing pottery & soldering.



Nitric acid. Is prepared from $NO NaO$ by the action of $SO_2 \cdot HO_2$. Equal weights of $NO NaO$ & $SO_2 \cdot HO_2$ give the acid, Coloumbes & in greatest quantity. On the large scale it is ~~is~~ distilled from a cast iron cylinder &

condensed in earthen vessels.

The SO_2H_2 used is also only $\frac{1}{2}$ the weight of the NO_2Na for though NO_2H is not produced in so large quantity the saving of SO_2H_2 is of more account. The reaction is as follows.



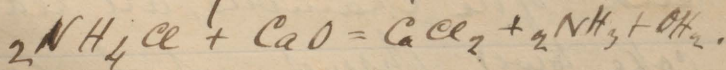
It is usually coloured by nitrogen trioxide or tetroxide.

NO_2H is ~~usual~~ generally contaminated by SO_2H_2 , (from splashing in the retorts) & HCl from the chlorides present in the crude NO_2Na .

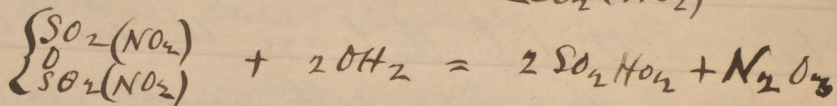
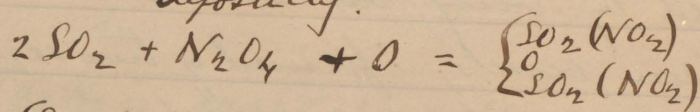
Ammonia. The great source of ammonia is ~~the~~ the distillation (destructive) of nitrogenised animal & vegetable substances, especially Coal & Bones. When they are subjected to destructive distillation in the manufacture of gas & animal charcoal, respectively.

The ammoniacal liquor (in which the ammonia occurs as Carbonate or Chloride) is first treated with laked lime, & then raised to the boiling point, when all the NH_3 is given off. This gas is passed into concentrated HCl till the solution of AmCl becomes so concentrated as to deposit crystals of AmCl . These are purified by being ~~sublimed~~ sublimed in spherical iron vessels, formed of two segments. Heat being applied to the lower the salt condenses on the upper side. The salt usually contains small quantities of Fe_2Cl_6 from the action of free HCl , & Cl from decomposed NH_4Cl on the iron vessel.

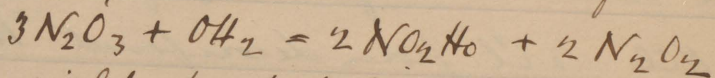
From NH_4Cl , NH_3 may be easily obtained by CaO .



SO₂HO₂ is prepared commercially by oxidising the SO₂ evolved from ^{burning} copper or iron pyrites by N₂O₄, which acts as a carrier between the SO₂ & the air. It forms a white crystalline compound with the SO₂HO₂ which is, afterwards decomposed by OH₂ into SO₂HO₂ & N₂O₃. In actual practice sufficient steam is admitted to keep this compound from ever depositing.



The N₂O₃ by contact with water forms



These yield fresh portions go to the SO₂.

The nitrous fumes which pass off at the end of the chambers, are led up through a coke tower, through which concentrated SO₂HO₂ drips, & being absorbed by it, are lead back by a pipe to a tower at the beginning of the chambers where the solution falls over a succession of shelves & the nitrous fumes are absorbed by the hot

Current of SO_2 & steam & lead back to the chambers.

1 lb of S gives three of SO_2 & H_2O & .08 lb of sodic nitrate is employed in oxidising it.

The acid is not allowed to rise above $\frac{1}{10}$ grain 1.6 in the chambers, as above this point it attacks the lead so much. It is afterwards concentrated in shallow lead dishes & pans, & then in vessels of glass or platinum.

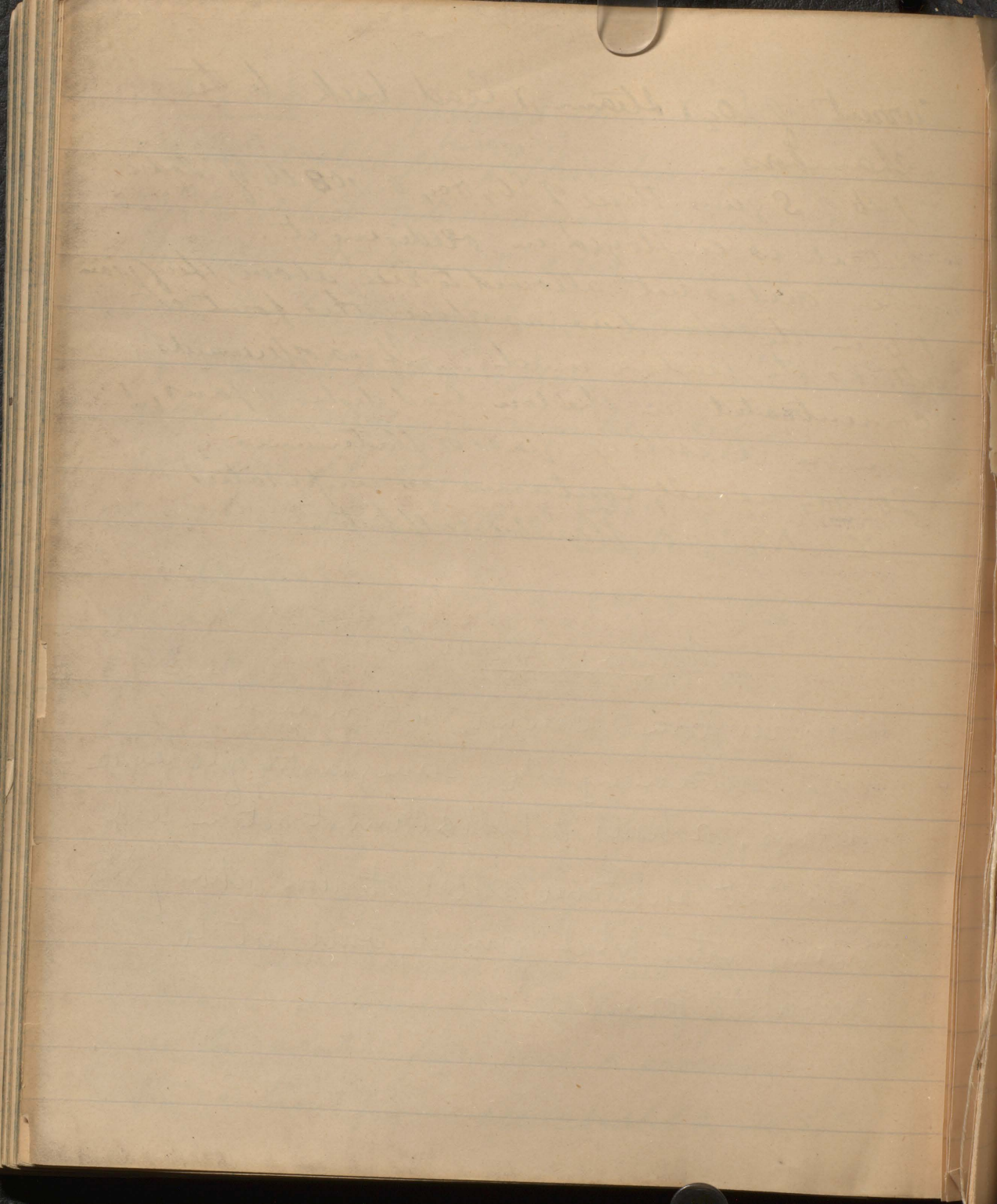
SO_2 & H_2O usually contains as impurities Cl, N_2O_3 & plumbic sulphate.

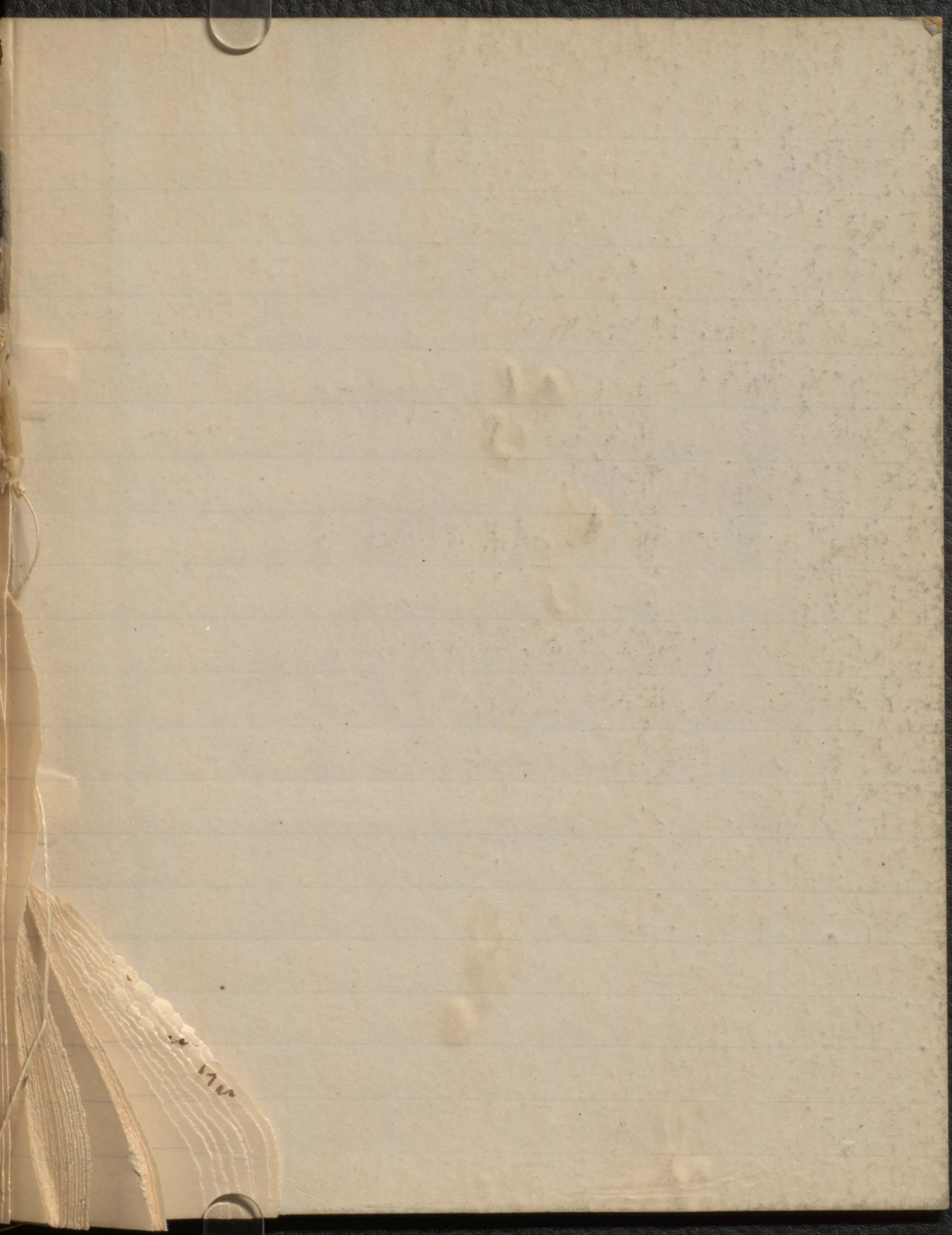
Action of H_2O on Pb

Water free from O cannot act on lead.

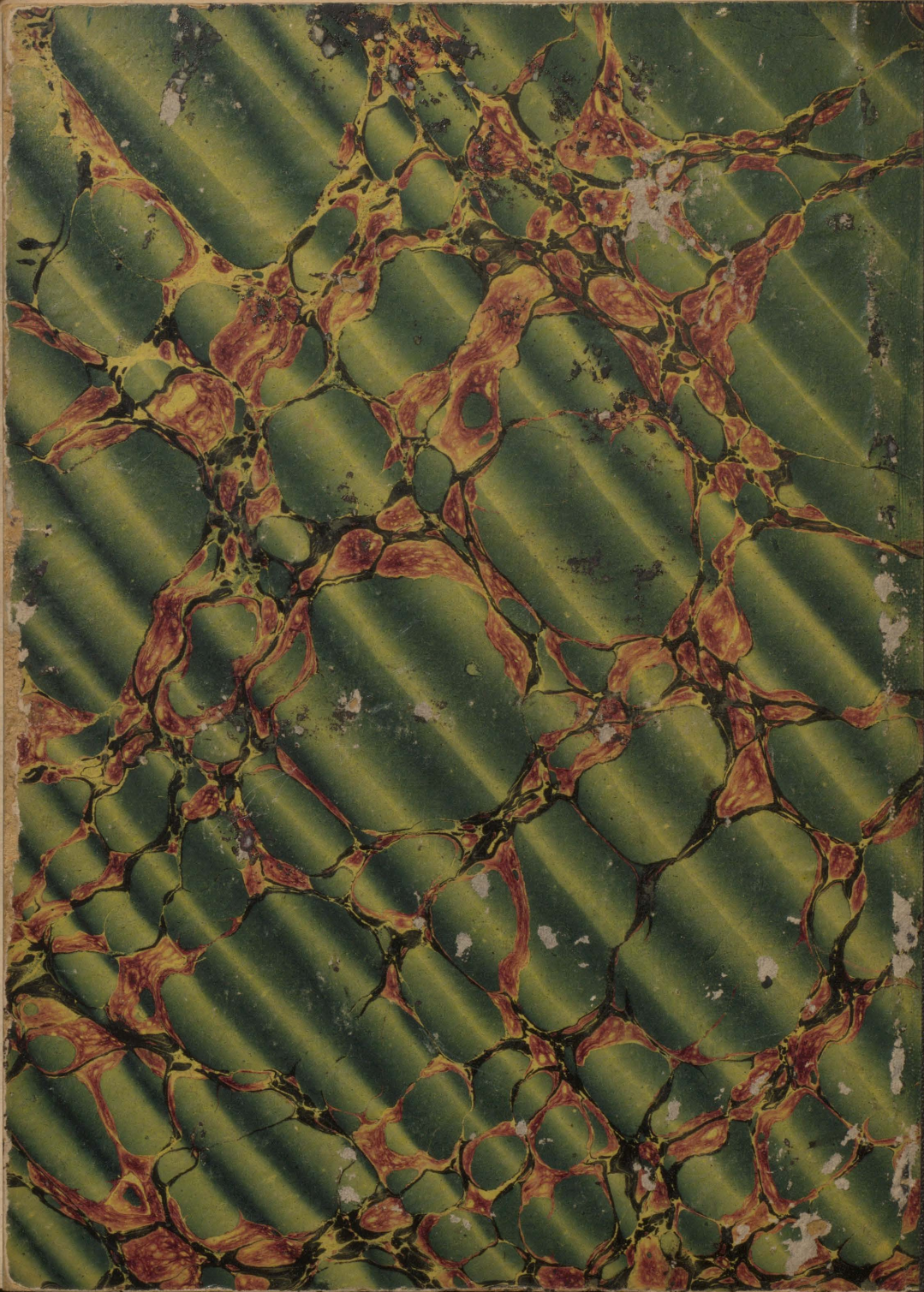
Water containing CO_2 , some quantity of CaCO_3 or CaMg , or traces of POH_3 cannot act on lead.

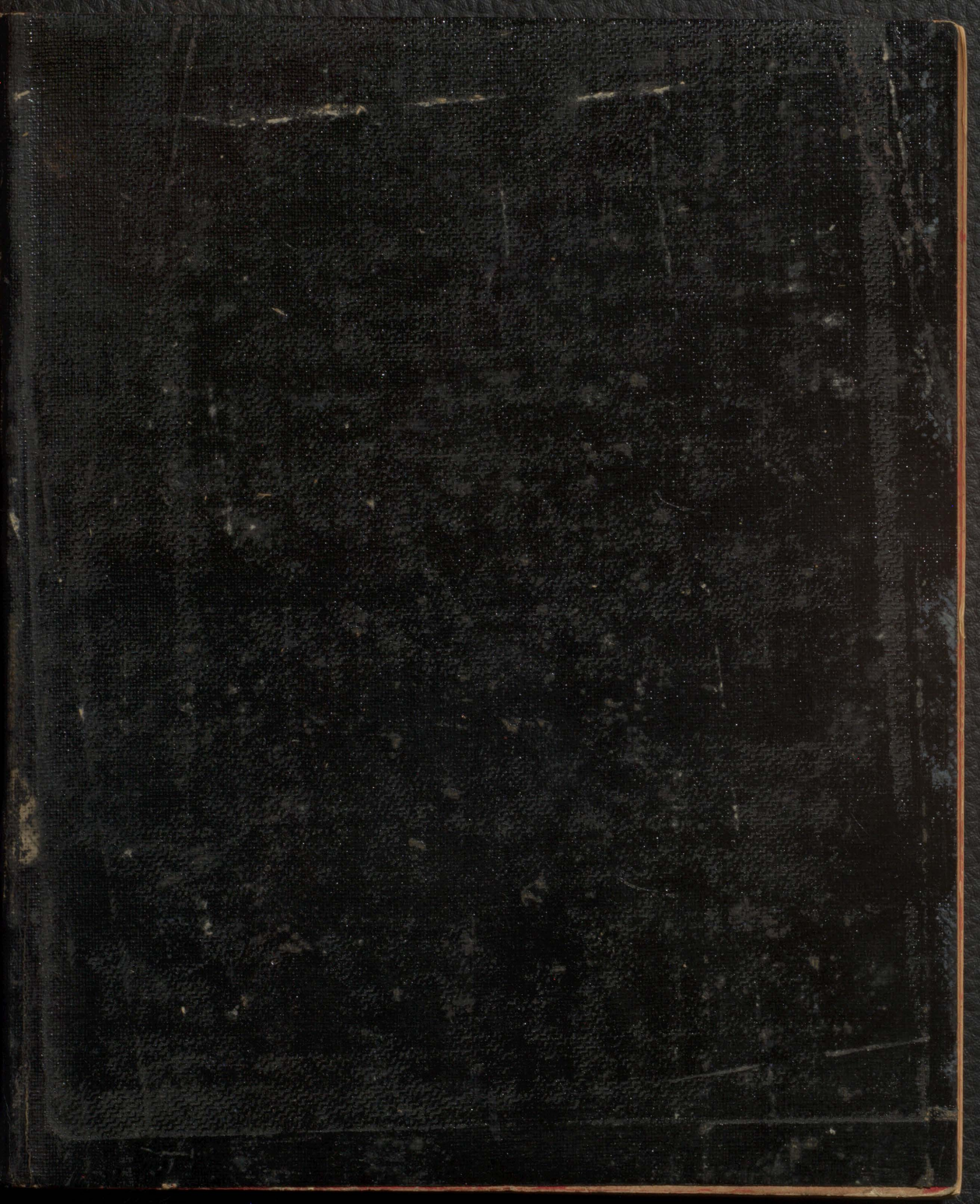
This last substance explains the non action of ~~the~~ many waters which formerly could not be accounted for.





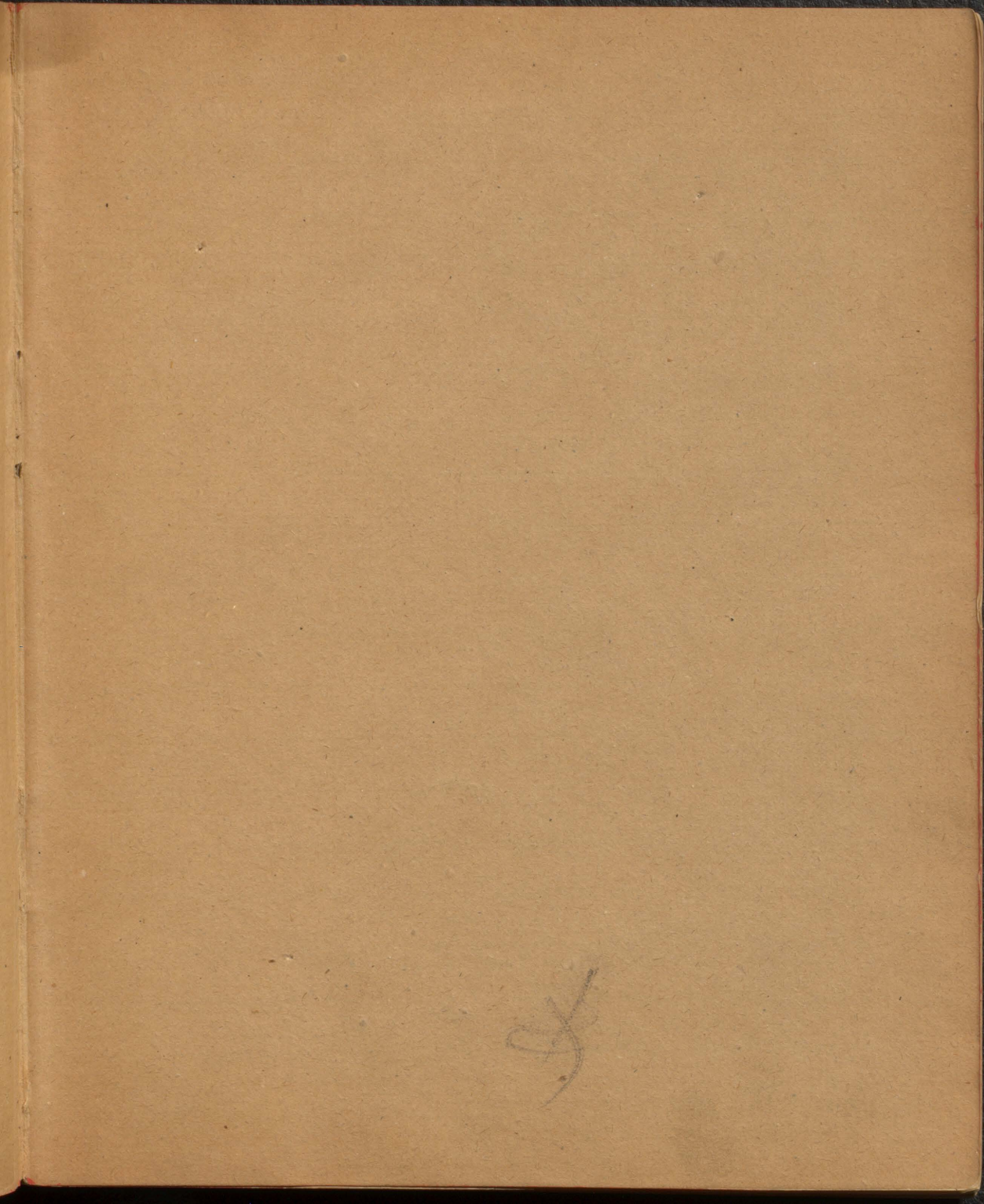
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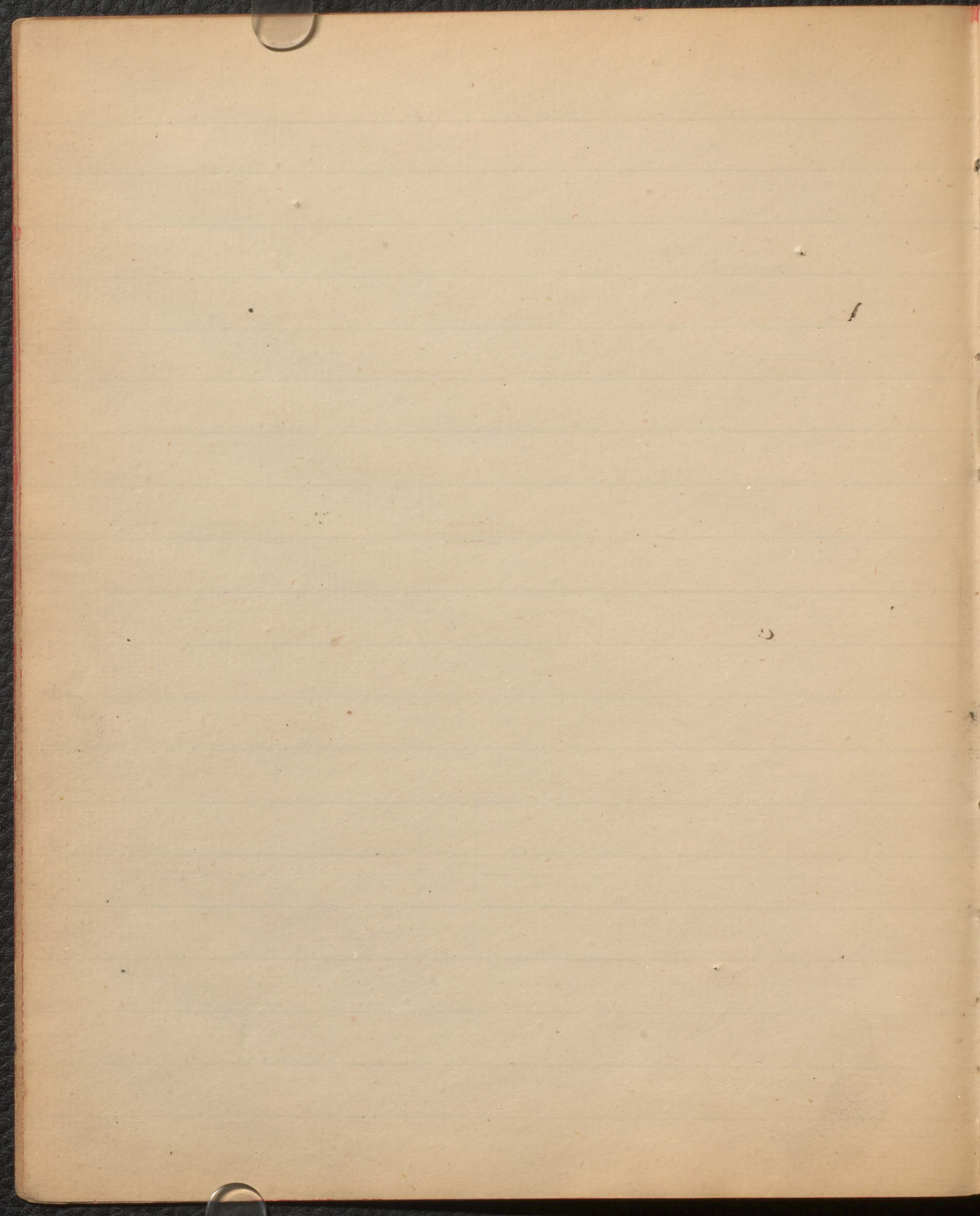




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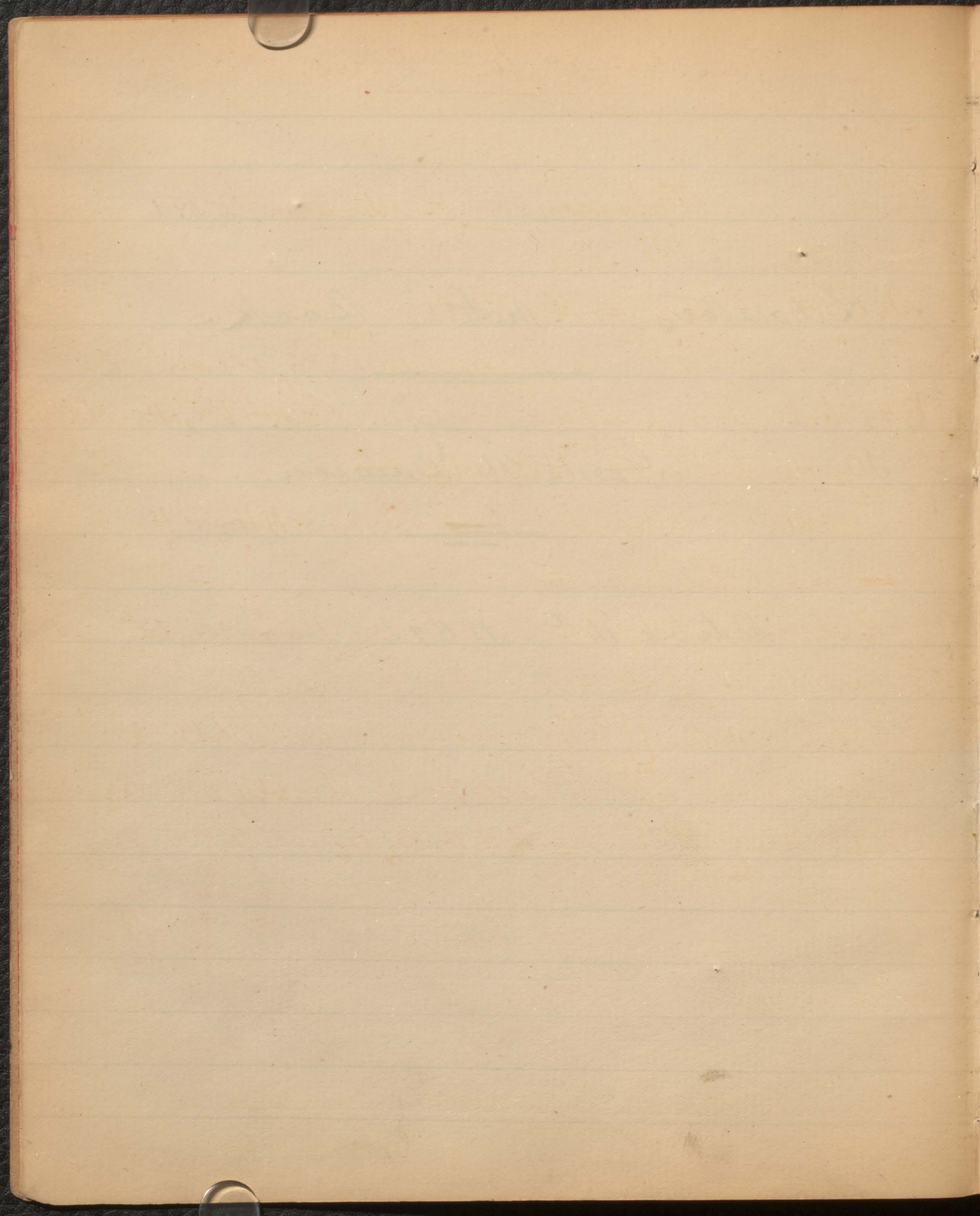




Laboratory note Book.

George M. Dawson.

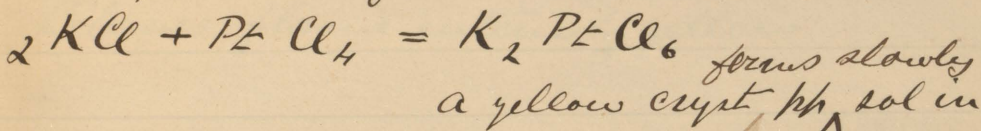
October 14th 1869.



Reactions for Bases.

Potassium. K Atomic weight 39.1

Employed a sol of KCl

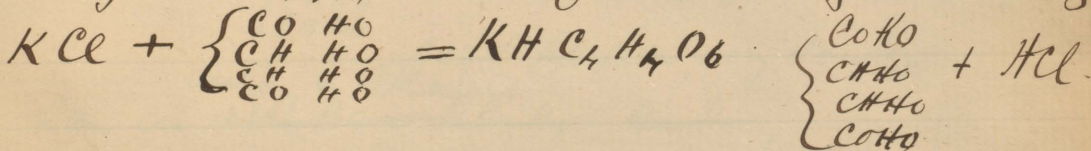


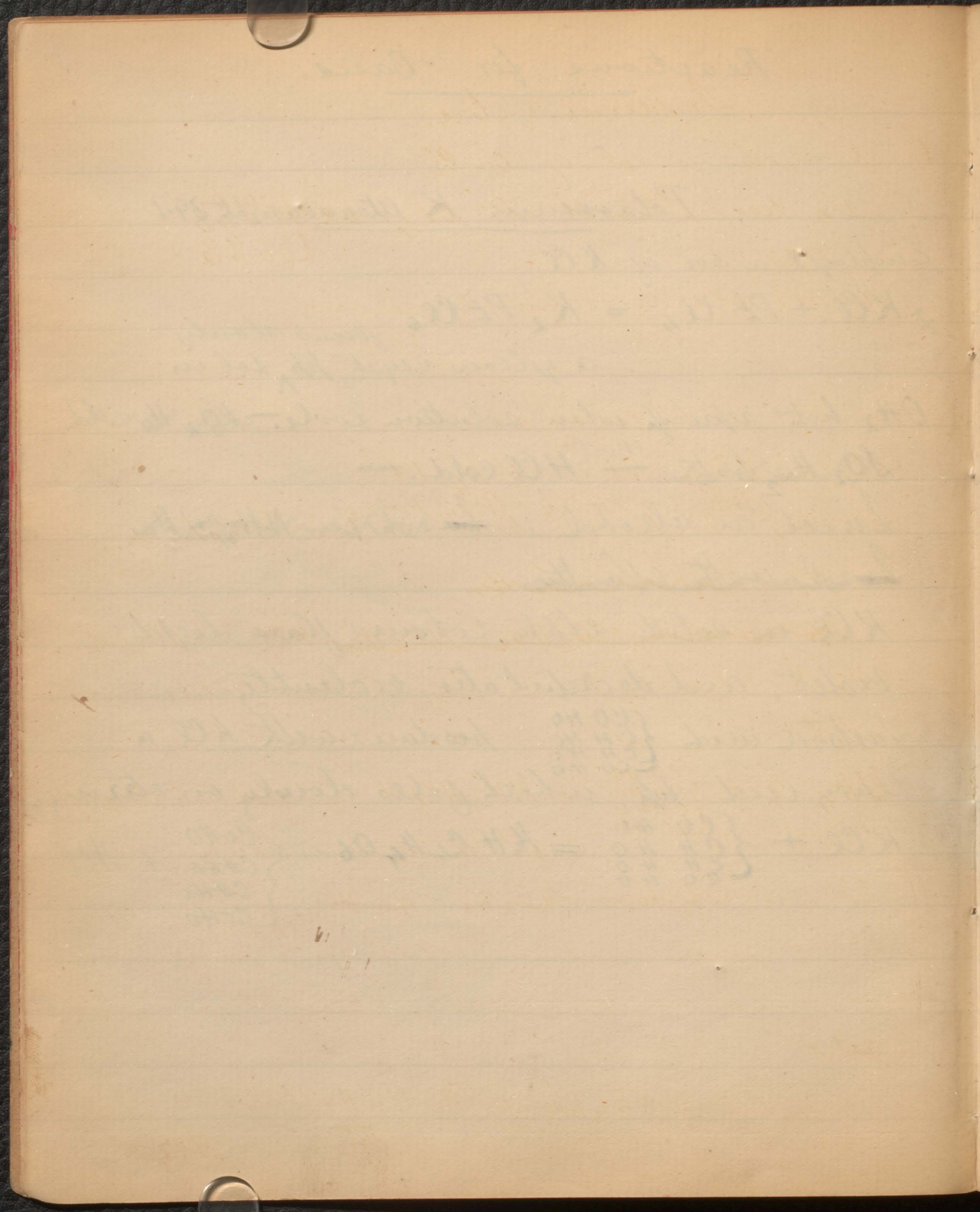
OH_2 hot reprecip when solution cools. — ~~$\text{K}_2 \text{PtCl}_6$ cold~~
 ~~SO_2 hot~~ $\xrightarrow{\text{hot}}$ HCl cold. —

~~Lusol in alcohol. Lusol in NH_4 + H_2O~~
~~Lusol with Cl_2 + H_2O~~

KCl in solid state colours flame light violet, and decrepitates violently.

Tartaric acid $\begin{cases} \text{CO} & \text{HO} \\ | & | \\ \text{CH} & \text{HO} \\ | & | \\ \text{CO} & \text{HO} \end{cases}$ produces with KCl, a heavy crist hp , which falls slowly on stirring.





Sodium. Na

Employed a sol of ca Cl.

No precip with Pt Cl₄ or $\begin{cases} \text{CO} & \text{HO} \\ \text{CH} & \text{HO} \\ \text{C} & \text{HO} \\ \text{CO} & \text{HO} \end{cases}$

Colours flame intensely yellow.

Ammonium

Employed a sol of ca H₄ Cl.

Pt Cl₄ ^{2NH₄Cl + PtCl₄ = (NH₄)₂PtCl₆} produces a heavy yellow cryst ppt

~~ppt soluble in H₂O~~

~~soluble in SO₂, H₂O, NO₂, H₂O, HCl.~~ ^{insol. in} & Alcohol.

NH₄ Cl when heated in dry state volatilises in white fumes.

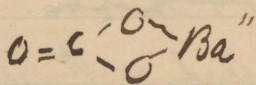
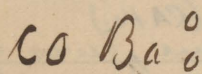
NH₄ Cl + $\begin{cases} \text{CO} & \text{HO} \\ \text{CH} & \text{HO} \\ \text{C} & \text{HO} \\ \text{CO} & \text{HO} \end{cases}$ = NH₄HC₄H₄O₆. acid tartrate of ammonium

^{cryst ppt falls very slowly}
sol in ~~SO₂, H₂O, NO₂, H₂O, H₂O.~~ ^{and alkalis}

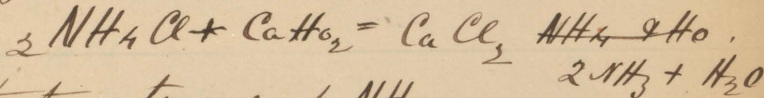
NH₄ Cl in dry mixed with quick lime ^(CaH₂O₂) gives off ammoniacal smell, and changes ~~blue~~ ^{red} litmus paper to ~~red~~ blue

Used a sol of NH₄ Cl, with Na Ho (sodic hydrate) gently heated in test tube gives off ammonia NH₃ recognisable by smell.

Put a ves



Put a very minute quantity of NH_4Cl in porcelain crucible and covered it with a watch glass, with a slip of moist litmus paper beneath. Added CaH_2 and heated gently when the escaping ammonia coloured the litmus blue.



For detecting traces of NH_4

Take a very weak sol of NH_4Cl , and a watch glass and added a drop of HgCl_2 , and then a few drops of CO NaO_2 which produced a white flaky precipitate, when HgCl_2 & CO NaO_2 were added in to great quantities a yellow precipitate was formed.

Barium. Ba.

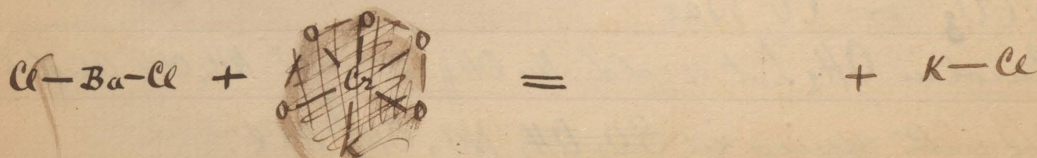
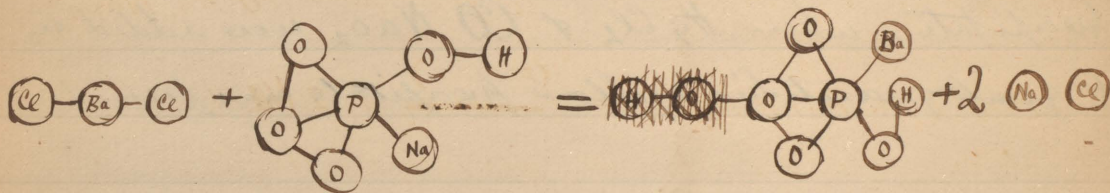
BaCl_2 colours flame a greenish yellow.

Employed a sol of BaCl_2 . $\text{BaCl}_2 + \text{CO AmO}_2 = \text{BaCO}_3 + \text{AmCl}$
 $\text{BaCO}_3 + \text{BaCl}_2 + \text{CO AmO}_2 = \text{CO Bao} + \text{AmCl}$
 CO AmO_2 throws down a white, very light $\frac{2}{3}$ of BaCO_3 or CO Bao

Insol in OH_2 hot or cold. NaOH hot or cold. NH_4OH . Alcohol

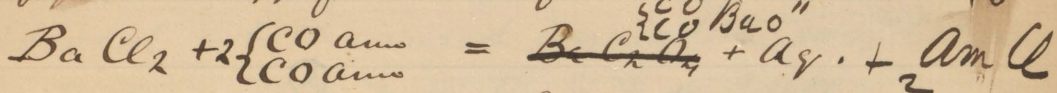
Sol with effervescence in SO_2 , OH_2 , NO_2 , OH_2 , HCl .

Decomposed with escape of CO_2 by SO_2 , OH_2 , and formation of ~~acidic~~ Basic Sulphate, a heavy white sp.



$\begin{matrix} \{ \text{CO Am} \\ \{ \text{CO Am} \end{matrix}$ $\xrightarrow{\text{Basic}}$ BaCl_2
Oxalate of ammonia with BaCl_2 throws down

a flocculent ppt of oxalate of barium ($\text{BaC}_2\text{O}_4 + \text{H}_2\text{O}$)



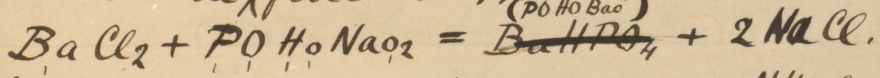
Insol in OH_2 hot or cold, $\text{SO}_2 \text{OH}_2$ hot or cold, ~~NaOH cold~~
 ~~NH_4OH~~

Sol in $\text{NO}_2 \text{OH}$, HCl .

Would not dissolve in $\begin{matrix} \{ \text{CO Ho} \\ \{ \text{CO Ho} \end{matrix}$ or $\begin{matrix} \{ \text{C}_2\text{H}_3 \\ \{ \text{CO Ho} \end{matrix}$ (Oxalic or acetic acids) the precipitation not being sufficiently recent, or acid not strong enough.

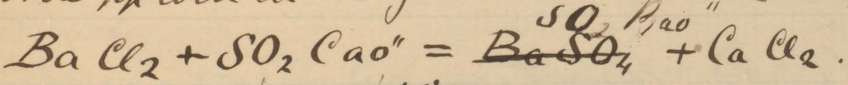
Filter off & test filtrate with $\text{SO}_2 \text{Ho}_2$

(With BaCl_2 , Hydric disodic phosphate (PO Ho NaO_2) gives a white ^{heavy} flocculent ppt (PO Ho BaO)



Sol in acids, Sol with difficulty in $\text{NH}_4 \text{Cl}$.

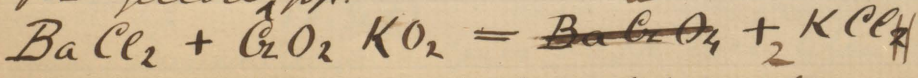
BaCl_2 with $\text{SO}_2 \text{CaO}$ (Calcic sulphate) gave fine white ppt even in very dilute solutions



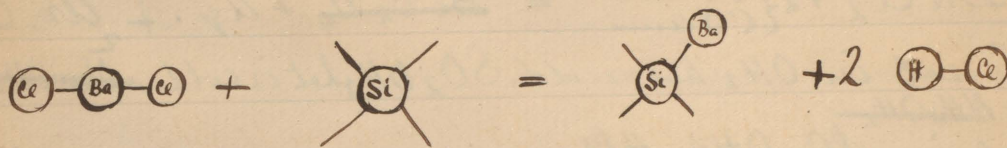
Insol in alkalis, ^{very} slightly sol in strong boiling HCl and $\text{NO}_2 \text{H}$.

Produced the same ppt by $\text{BaCl}_2 + \text{SO}_2 \text{Ho}_2$.

BaCl_2 with $\text{CrO}_2 \text{KO}_2$ (Potassic Bichromate) gives a light yellow ^{heavy} ppt ($\text{CrO}_2 \text{BaO}$)

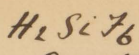


ppt dissolves readily, and gives light yellow solns with $\text{NO}_2 \text{OH}$ & HCl . sols espec by $\text{NH}_4 \text{Ho}$.



SrO Antia

SrO = SrO"



{ Ba Cl₂ with ~~SiF₄~~ gives a white heavy ph.
 but forms very slowly, added, equal volumes of
 alcohol which caused immediate precipitation.
 Ba Cl₂ + H₂SiF₆ = Ba Si F₆ + 2 HCl.

Strontium. Sr. Comb weight - 87.5

{ Sr Cl₂ in dry state colours flame a vivid red.
 Sr Cl₂ with ^(Ammoniac carb) CO Amoz gives white, fine, ph
 Sr Cl₂ + ~~CO~~ Amoz = Sr CO₃ + 2 Am Cl. ^{CO Ho"}
 { Sr + {CO Amoz (Ammoniac oxalate) = Sr Cl₂ ^{CO Ho"} + 5ag
 produces a white fine ph easily sol in NH₂OH & HCl.

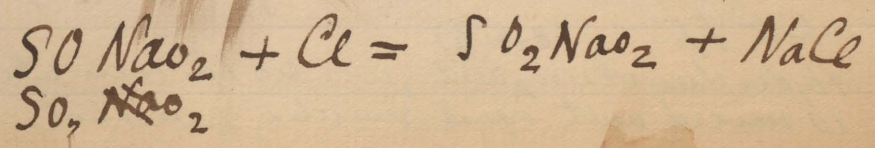
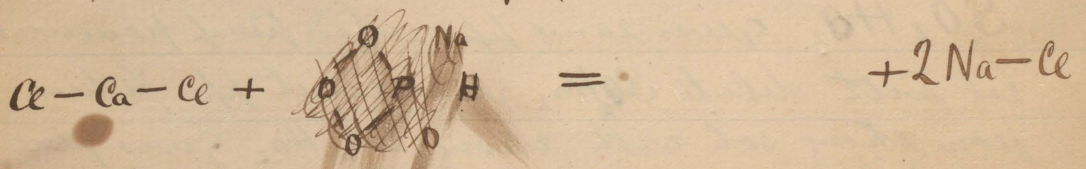
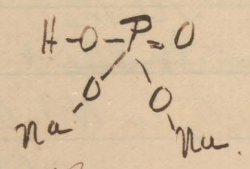
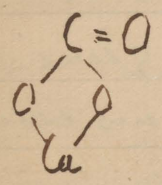
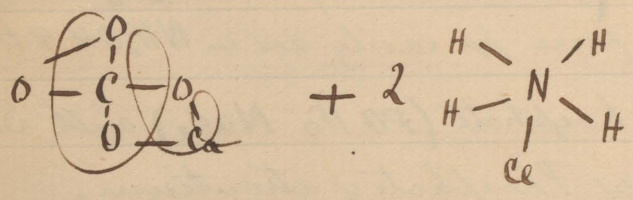
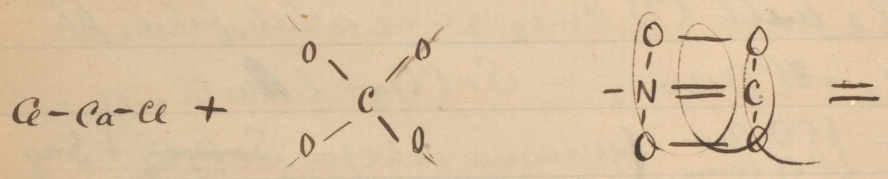
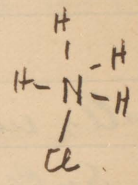
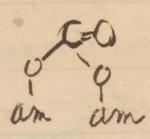
Hydric disodic phosphate (PO Ho NaO₂) with Sr Cl₂ gives white ph of Phosphate of strontium.

Sr Cl₂ with Calc chloride (SO₂ Cao") gives a white ph which even with strong sol forms very slowly.

Sr Cl₂ + SO₂ Cao' = Sr SO₄ ^{SO₂ Ho"} + Ca Cl₂
 dissolves very sparingly in NO₂OH & HCl.

SO₂ HO₂ gives same ph, when precip from weak sol with dilute SO₂ HO₂ gives crypt ph. When from strong sol with strong SO₂ HO₂ gives flocculent white ph

(H₂SiF₆)
 Hydrofluoric acid gives no ph even when the sol is mixed with equal quantity of alcohol



Calcium, Ca, Atom Weight 40

Specific grav 1.58

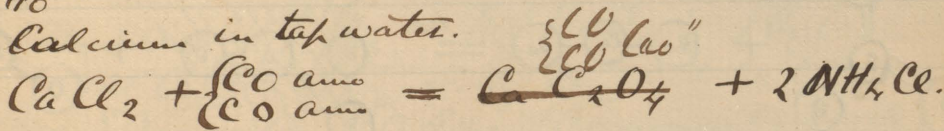
"CO Cao" in dry state colour flame a faint reddish yellow.

Ca Cl₂ with CO Am₂ gives white flocculent ppt which readily dissolves in NH₄ Cl, but is afterwards partially re-deposited. On the application of heat to the ppt of "CO Cao" it shrinks and becomes crystalline & heavy.

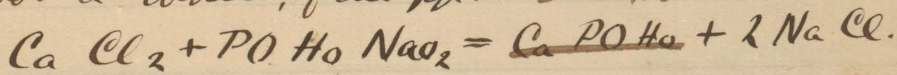


Ca Cl₂ with $\begin{cases} \text{CO Am}_2 \\ \text{CO Am}_2 \end{cases}$ (Ammonia Oxalate) gives a white, light ppt. which dissolves easily in NO₂ Ho & HCl, but not perceptibly in $\begin{cases} \text{CO Ho} \\ \text{CO Ho} \end{cases}$ (Oxalic) or

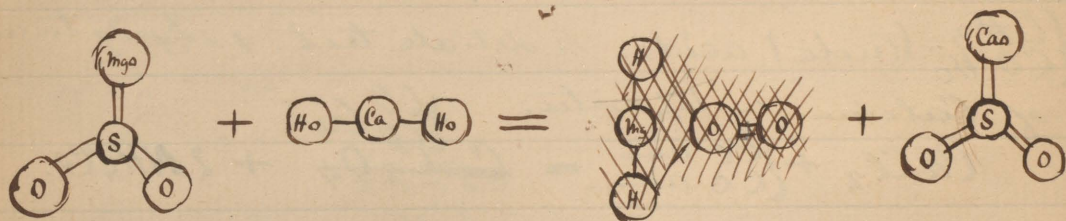
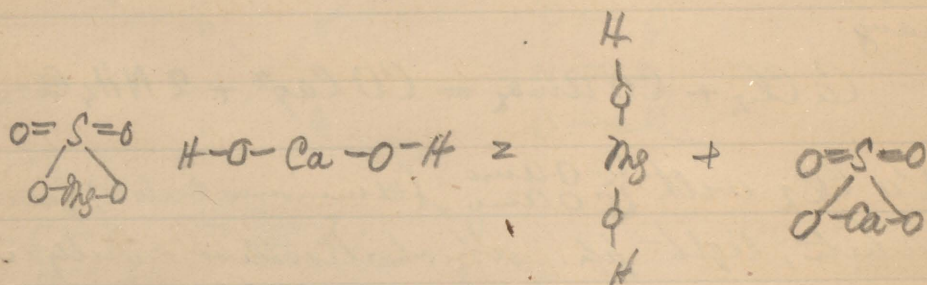
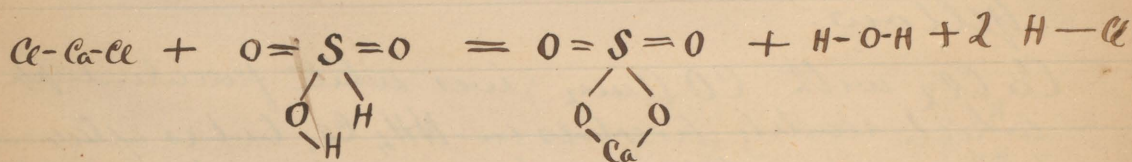
$\begin{cases} \text{C}^{\text{H}}_3 \\ \text{CO Ho} \end{cases}$ (Acetic) acids. A delicate test, & shows traces of Calcium in tap water.



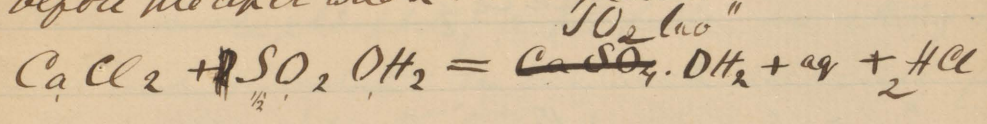
Ca Cl₂ with PO Ho Na₂ (Hydroxy disodic phosphate) gives a white, fine ppt. PO Ho Cao



Sodic phosphate gives no ppt with sol of Ca Cl₂



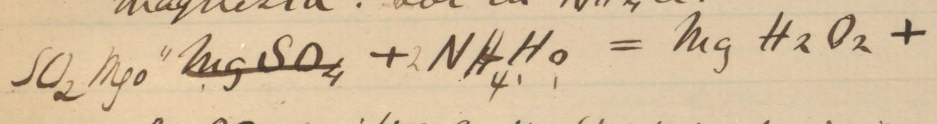
Ca Cl₂ with SO₂ O H₂ gives in strong sols a white crypt pp. In weak sols alcohol has to be added before precipitation takes place.



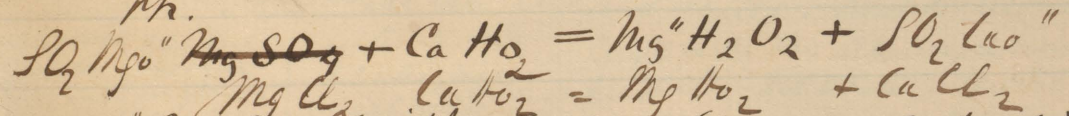
H₂ Si F₆ & CrO₂ KO₂ give no pp with salts of Ca.

Magnesium, Mg. 24.0

Employed a sol of ~~Mg SO₄~~ (Magnesium sulphate) SO₂ Mg^o
SO₂ Mg^o "~~Mg SO₄~~ with NH₄ HO gives pp of hydrated magnesia. sol in NH₄ Cl.

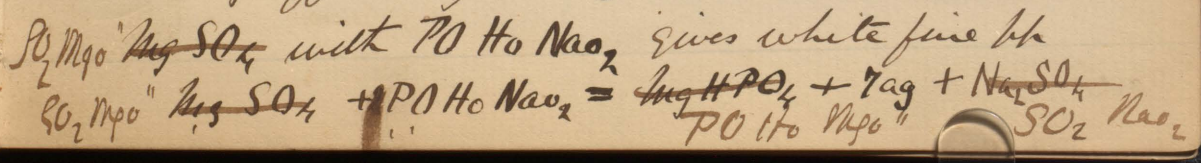


MgSO₄ with Ca HO₂ (hydrate of lime) gives the same pp.



SO₂ Mg^o "~~Mg SO₄~~ with CO Am₂ (Ammoniac carbonate) gives white flocculent pp, but not in presence of Ca Cl₂ except in very strong solutions.

{CO Am₂ (Ammoniac carbonate) gave no pp, sol not being sufficiently strong.



Insol. in abs. Alcohol.

$BaCl_2$ insol.

$CoCl_2$ sol.

$CaCl_2$ "

$MgSO_4$ " insol.

Barium "

Calcium Nitrate sol.

PO₂ H₂O

8

If NH₄Cl & NH₄ H₂O be added to Mg SO₄ no ppt
 but on adding to the mixture PO H₂O NaO₂
 (Hydric disodic phosphate) a ppt falls. In strong sols
 white and flocculent, in very weak sols crypt falls
 on stirring. (very delicate test.)

Separating the Metals in groups IV & V

Added to sol to be tested NH₄Cl and then CO Am₂O₂
 gave copious white ppt

ppt may contain Ba, Ca, Sr.
 washed ppt dissolved in HCl
 and evap to dryness. Treated ppt
 with alcohol (C₂H₅O) left residue
 residue dissolved in O₂H₂
 tested with considerable
 bulky SO₂ gas
 gave white immediate ppt

Ba

Mixed filtrate with SO₂ O₂H₂
 caused ppt filtered - boiled
 ppt with sulphate of ammonium
 (SO₂ Am₂O₂) and NH₄ H₂O left
 residue
 residue in flame
 gave red coloration

Sr

filtrate largely
 diluted, and
 mixed with CO Am₂O₂
 (ammoniac oedate
 gave a faint ppt

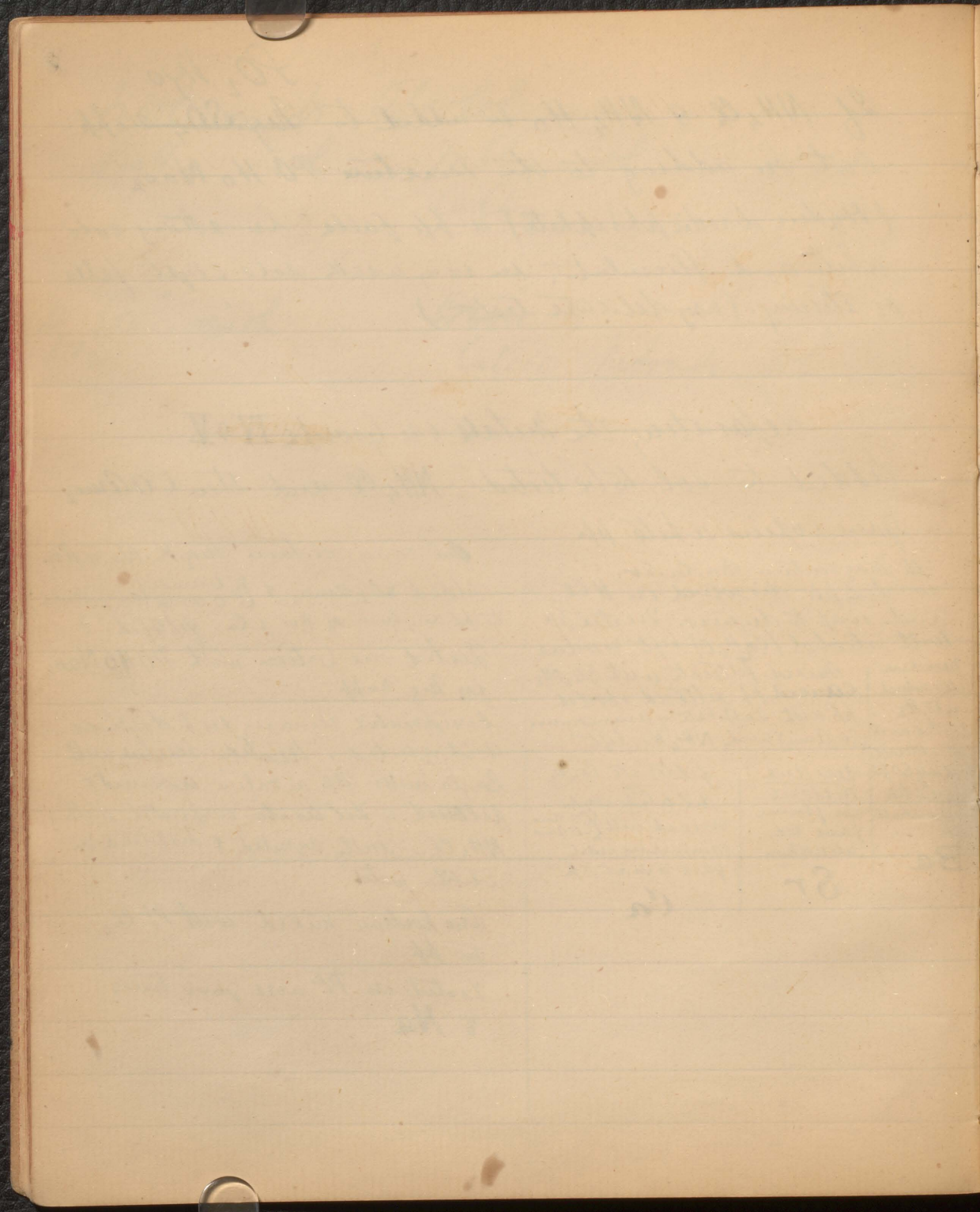
Ca

Sol may contain Mg, K, Na, or Am
 Added SO₂ Am₂O₂ & CO Am₂O₂ (Ammoniac Oedate)
 to ppt any traces of Ba or Ca. filtered. P
 Tested one portion with PO H₂O NaO₂
 for Mg no ppt.

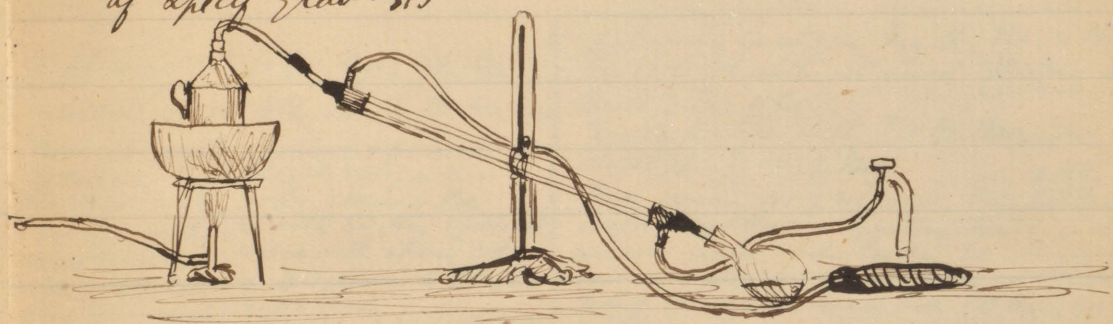
Evaporated remainder to dryness
 and ignited. Treated residue with
 Berzeta water till alkaline, Woured &
 filtered. Filtrate evaporated with
 NH₄Cl, gently ignited & dissolved in
 a little water

One portion mixed with Pt Cl₄
 no ppt

Tested on Pt wire gave traces
 of Na



Distilled Methylated Spirit: used this apparatus
and mixed the spirit with CaH_2 . Got it over
of Spec Grav. 815



Separation of metals in Groups III & IV Analysis 2nd

Precipitable with CO_2 am^o in presence of NH_4Cl

pp may contain Ca Ba Sr
evaporated to dryness & treated
with C_2H_6O left residue
residue
dissolved in H_2O
& added large
quantity of SO_2 am^o
pp

Ba

filtrate may contain
Sr Ca & traces of Ba
mixed with SO_2 am^o
& filtered. boiled pp
with SO_2 am^o &
 NH_4H_2O & filtered.
residue largely
tested for diluted
Sr in flame filtrate &
gave traces tested with
Sr CO_2 am^o
 CO_2 am^o
no pp

To get rid of traces of Ba or Ca mixed
sol with SO_2 am^o & CO_2 am^o. let it
stand for some time, & filtered.

May contain Mg K Na NH_4

Tested original pp & found no NH_4
Tested sol with PO_4 H₃ Na₂ for Mg
no pp.

Evap to dryness & ignited to get rid of
Mg or NH_4

Treated residue with H_2O warmed & added
Ba H_2O_2 tile alkaline & filtered.

Evap filtrate with NH_4Cl ignited
gently. Dissolved in a little water
filtered & tested for K gave trace K
Flame gave slight colour of Na

H-O-

Na-O-

K-O-

Na-O-O-Na

-O-13a-O-

-O-Na Na-O-

K-O-H-

OH₂

OHH

OKH

OK₂

OKH

NaHO

KHO

HO

Separation of Metals in groups IV & V. Analysis 3rd Oct 28th 1889.

Recapitulated by CO AmO₂ in presence of NH₄ Cl & washed.

pp.
pp may contain Ba. Sr. Ca
dissolved in HCl evap to dry mass
treated with alcohol & filtered
residue dissolved in OH₂
& treated with
considerable
bulk of SO₂ CaO
gave immediate
pp **Ba**

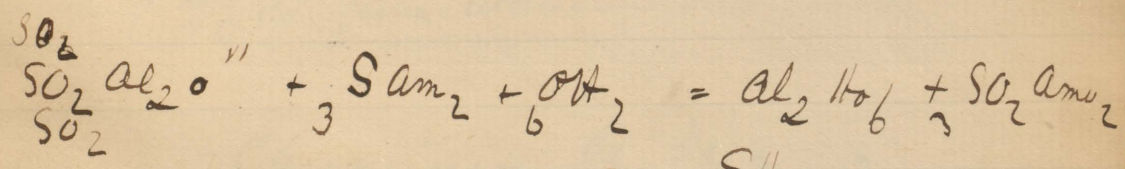
filtrate may contain Sr. Ca. & traces of Ba pp with SO ₂ Ho ₂ & filtered boiled with strong sol of SO ₂ Am ^o & NH ₄ Ho & filtered residue consists of Sr & traces of Ba. tested in flame gave colour of Sr	filtrate may contain Ca diluted with OH ₂ & treated with CO Am ^o gave pp Ca .
--	---

Sol may contain Mg. K. Na. & NH₄
mixed sol with SO₂ Am^o & CO Am^o to pp
traces of Ba or Ca
Tested portion with PO. Ho Na₂ gave very
slight pp. Traces of **Mg**.
Freed remainder of sol from Mg, ~~NH₄~~ & NH₄ by
evaporating to dryness igniting, heated with a little
warm water, and Ba Ho, till strongly alkaline
boiled & filtered. ~~From NH₄~~ filtrate to get
rid of excess of Ba mixed with CO Am₂ warmed
& filtered. Evaporated with NH₄ Cl to dry mass,
gently ignited. Dissolved in a little water
tested for K by Pt Cl₄ gave pp **K**
tested in flame for Na gave trace of **Na**
tested original sol for NH₄ by boiling with Natto gave
no smell of NH₄

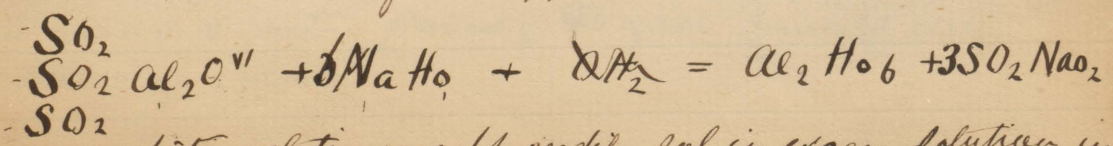
Reactions of Metals in group III.

Aluminium Al 27.5

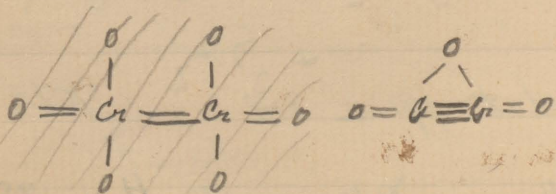
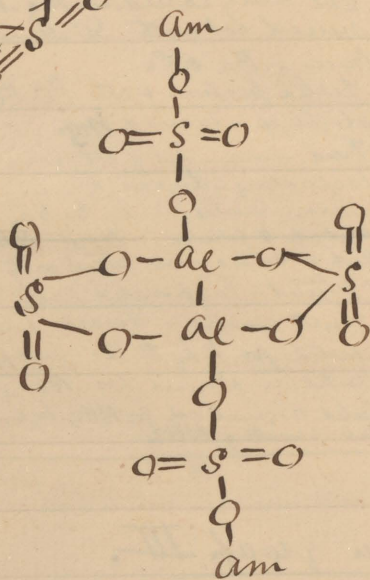
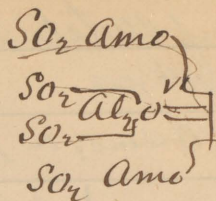
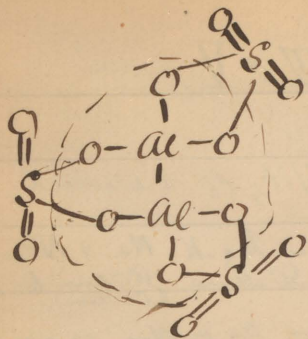
Employed a sol of Sulphate of aluminium

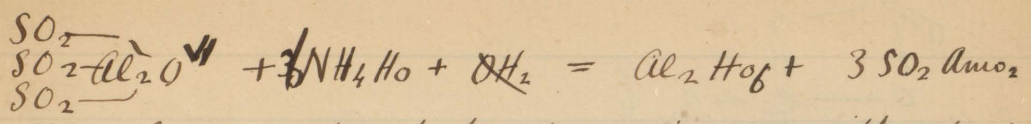


a white gelat. pp. - sol in KHO.

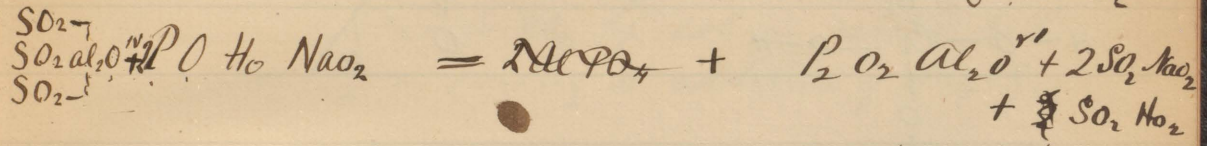
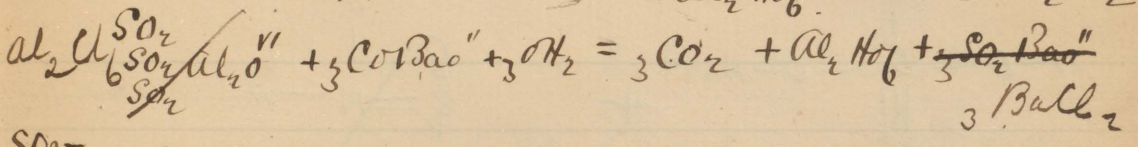
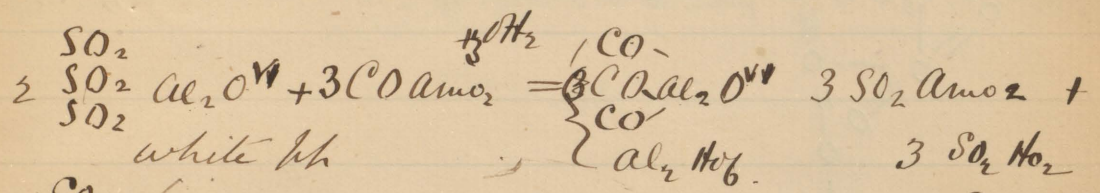


a white gelatinous pp readily sol in excess. Solution in excess pp by chloride of ammonium & warming





white gelatinous ppt which redissolves in excess with difficulty. boiling causes more copious ppt.

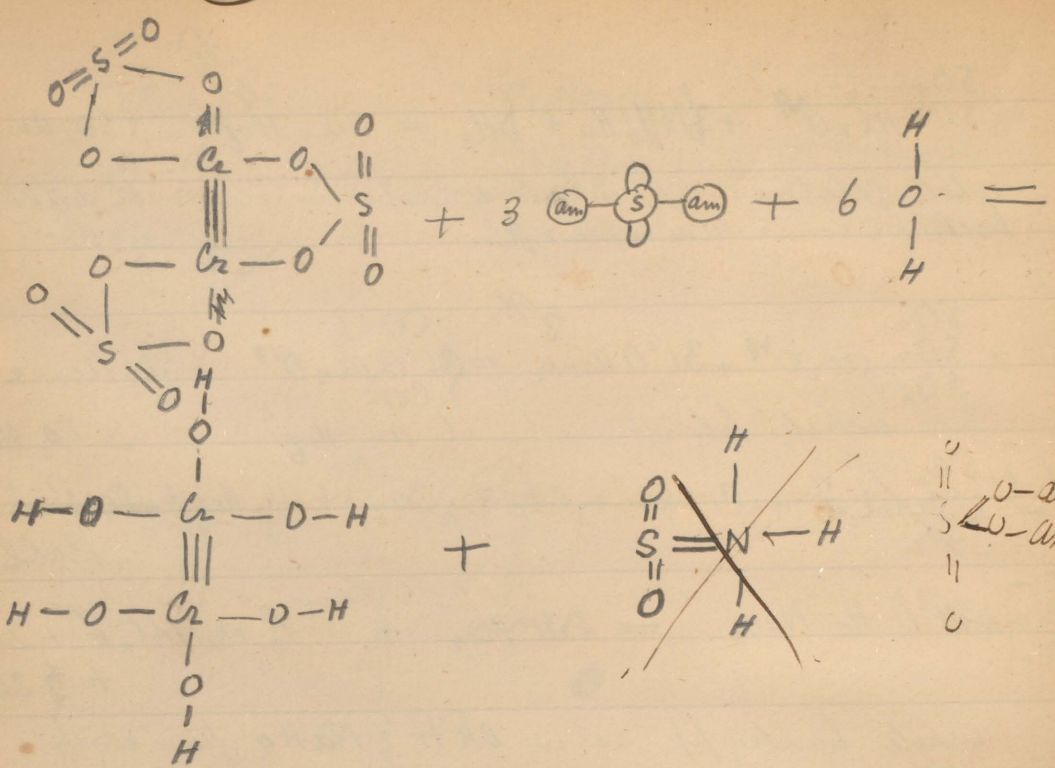


white bulky ppt sol in OH^- & NaHO from which NH_4Cl reprecipitates it. sol also in HCl & $\text{NO}_2 \text{HO}$ from which CH_3COHO reprecipitates it.

Blow-pipe Reaction. on charcoal Al gives with a drop of $\frac{\text{NO}}{\text{NO}} \text{Co}^{\text{II}}$ gives ultramarine blue mass.

Chromium Cr 52.5

Cr Employed Cr_2O_3 . with borax ($\text{B}_2\text{O}_3 \cdot \text{NaO}_2$) in inner & outer flame of bb gave emerald green bead when cold.



Fe^{VI}

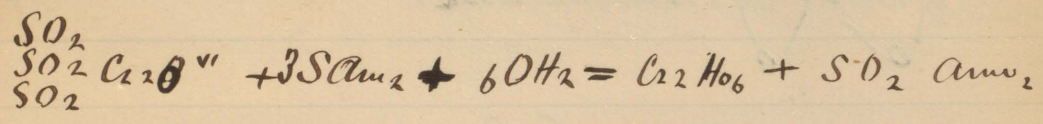
Fe^{IV}S₂

1 Fe^{III}O₂
1 Fe^{III}O

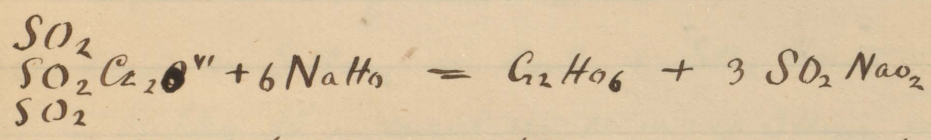
Fe^{II}O

CO Fe^{II}

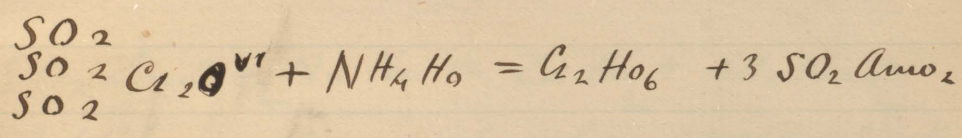
Employed sol of $\begin{matrix} SO_2 \\ SO_2 \\ SO_2 \end{matrix} Cr_2O'''$



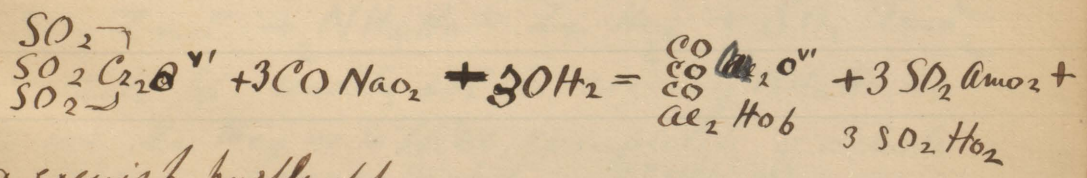
a bulky greenish yellow pp.



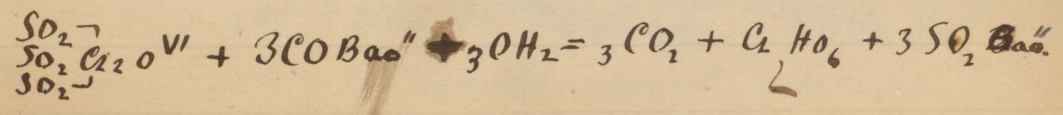
a greenish blue bulky pp sol in excess, but completely pp by boiling or addition of NH_4Cl .

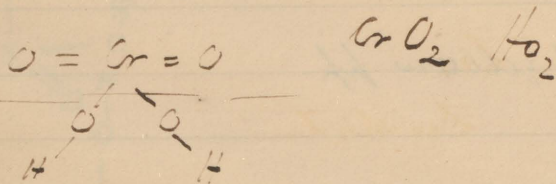
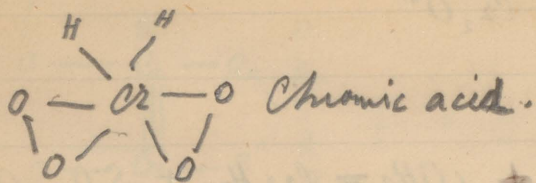


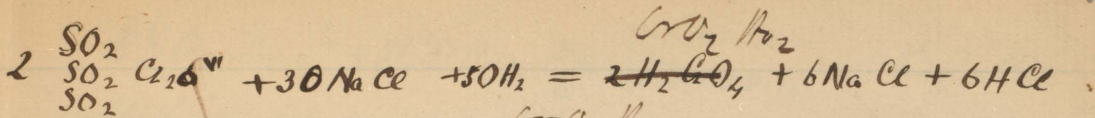
a bulky pp either green or purple according to strengths of sols &c. gives pink sol in excess of NH_4HO but pp's entirely on boiling.



a greyish purple pp



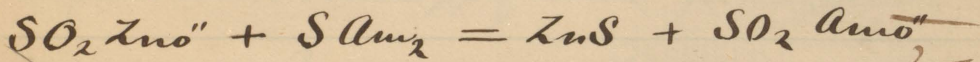




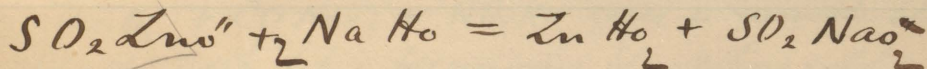
The formation of $\overset{\text{CrO}_2 \text{H}_2}{\text{H}_2 \text{CrO}_4}$ colours the liquid yellow it is favoured by boiling

Zinc Zn.

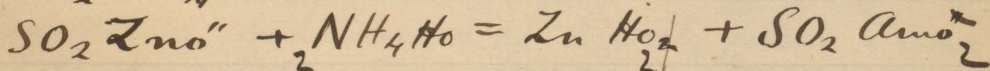
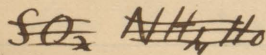
Employed a sol of ~~Zn~~ $\text{SO}_2 \text{ZnO}''$



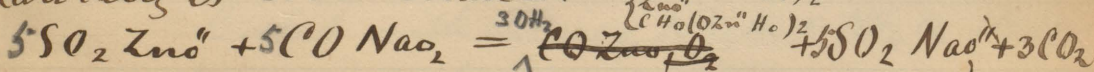
White bulky pp. insol in excess of SAm_2 or in NaHo or $\text{NH}_4 \text{Ho}$. Sol in $\text{NO}_2 \text{Ho}$, $\text{SO}_2 \text{Ho}_2$, HCl
 $\text{NH}_4 \text{Cl}$ helps ppt'n in dilute sols.



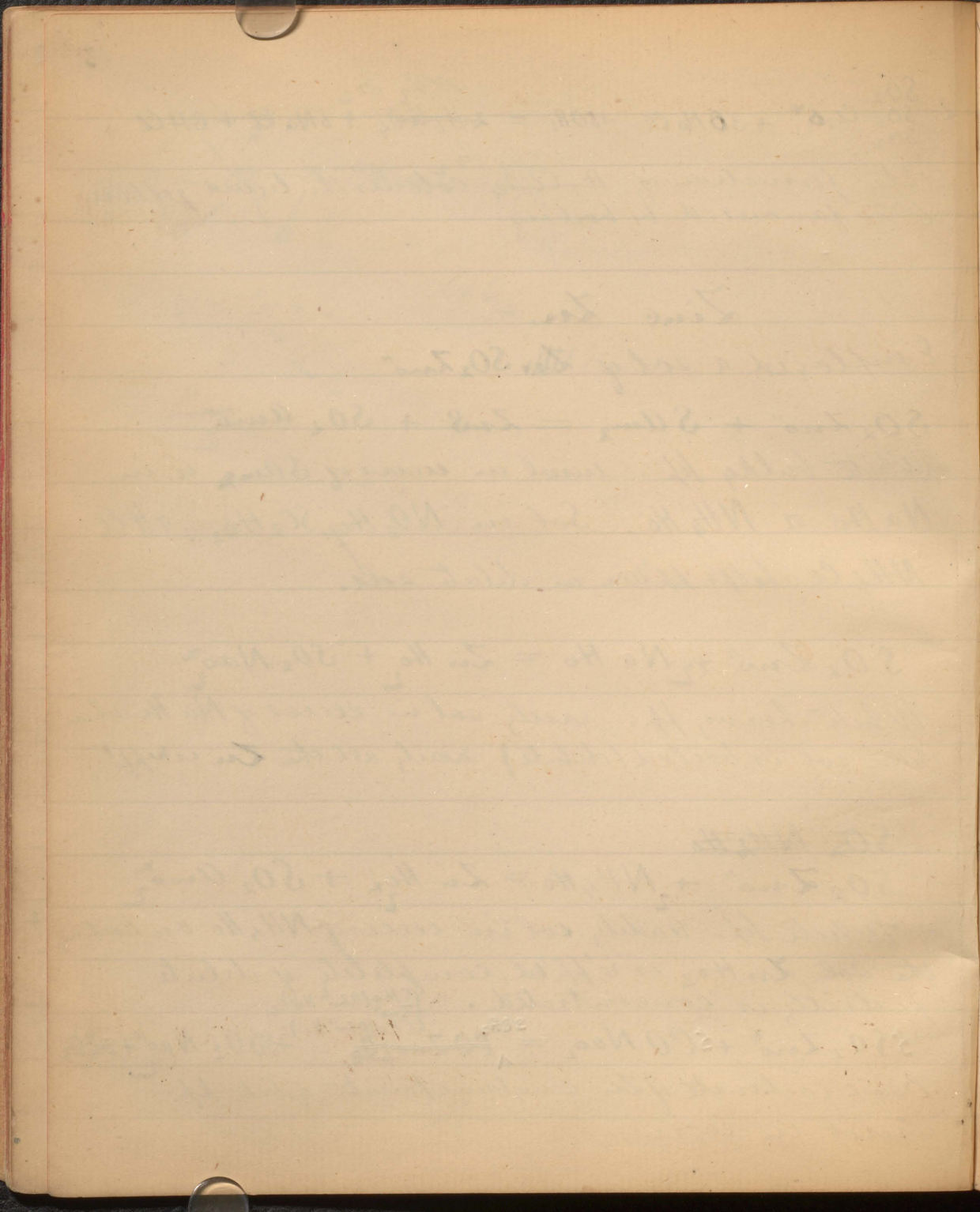
White heavy pp. easily sol in excess of NaHo when this sol is boiled (dilute) nearly all the Zn is ppt'



White pp. readily sol in excess of $\text{NH}_4 \text{Ho}$ on boiling the sol ZnHo_2 is re'ppt'd, completely if dilute partially if concentrated.

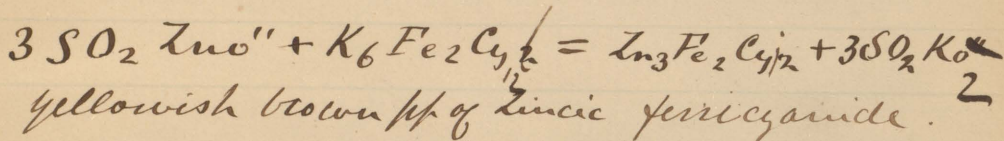
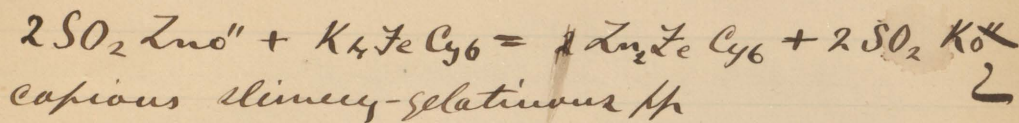


Basic carbonate of Zn semitransparent gelat pp. insol in excess.





White ppt readily sol in excess.



Manganese Mn 55.

Dry reactions

MnO₂ Heated in borax bead in outer flame of ppt gives when cold amethyst bead.

MnO₂ + CO NaO₂ + NO₂ KO gives a greenish blue bead with ppt. becoming blue when cold.

Wet reactions

Employed a sol of MnCl₂



yellowish flesh coloured ppt rapidly forms a brown pellicle on its surface, in contact with air of Mn₃O₄ (sesquioxide).

Insol in alkalis, & in excess. Sol in NO₂ H₂O, HCl, & {COH₃ / COH₂. Boiled with excess of NH₄H₂O & NH₄Cl the ppt changes to green anhydrous sulphide.

[Faint, illegible handwriting on lined paper, possibly bleed-through from the reverse side.]

$MnCl_2 + 2KHO = MnHO_2 + 2KCl$
 whitish gelat bp rapidly ^{hydrates by heat} browns by formation of Mn_3O_4

$MnCl_2 + NH_4HO = MnHO_2 + 2NH_4Cl$
 whitish gelat bp rapidly browning. pptn prevented by presence of NH_4Cl

$MnCl_2 + K_4FeCy_6 = \cancel{MnK_4FeCy_6} + 2KCl$
_{ferrocyanide}
 a reddish white ppt sol in HCl

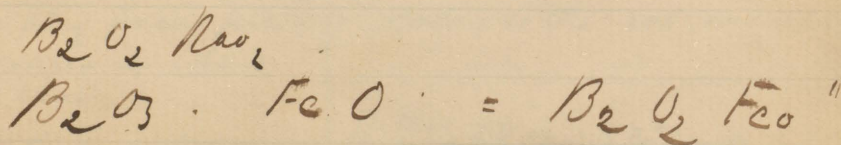
$3MnCl_2 + K_6Fe_2Cy_{12} = Mn_3Fe_2Cy_{12} + 6KCl$
_{ferrocyanide} _{ferrocyanide}
 brown ppt. insol in HCl & NH_4HO

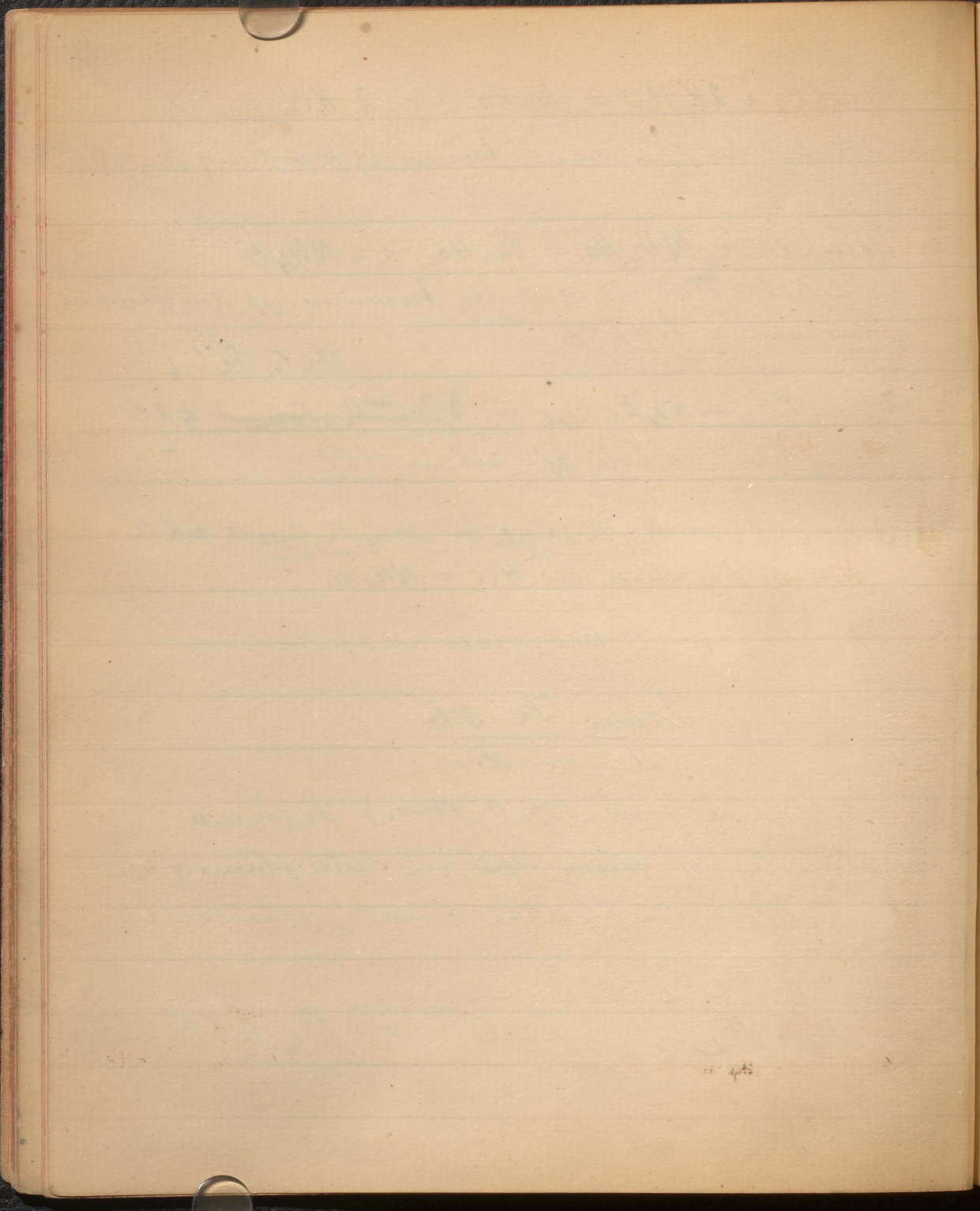
$MnCl_2 + CO Bao$ gives no ppt.

Iron Fe 5-6

Dry reactions.

With Borax beads ($B_2O_3 \cdot Na_2O$) Fe gives a colourless or yellow bead in outer flame of bp. & a bottle green in the inner, when cold.



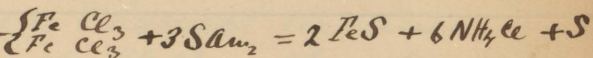
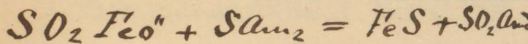


Fe^{II} Wet reactions

Fe^{III} IV

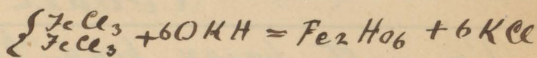
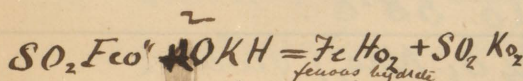
Employed a sol of SO₂ Fe^{II}

Employed a sol of { Fe^{II} Cl₃ / Fe^{III} Cl₃ }
Fe^{III} Cl₃ + SH₂ = 2 Fe^{II} Cl₂ + 2 HCl + S
turns sol milky, from pp'd. S



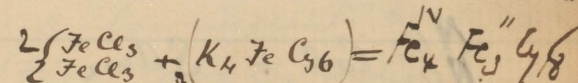
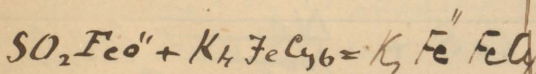
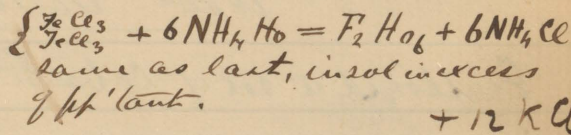
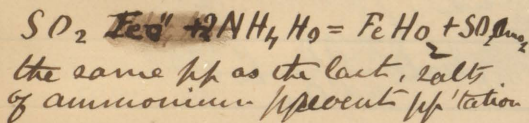
black dense pp, insol in alkalis
sol in HCl & NO₂HO. turns brown in
air. Highly dilute sols give green
colouration, afterwards pp.

black dense pp in sol in alkalis
sol in HCl & NO₂HO. turns brown in
air



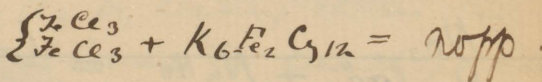
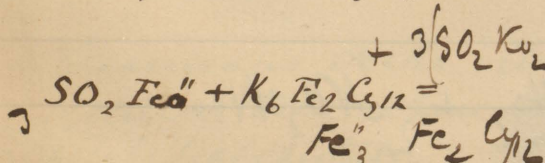
bulky whitish pp becomes
green + ultimately reddish brown

bulky reddish brown pp of ferric
hydrate



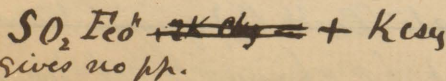
bluish white, becoming
blue by absorption of O from air

fine pp of prussian blue insol
in HCl but decomposed by Na HO



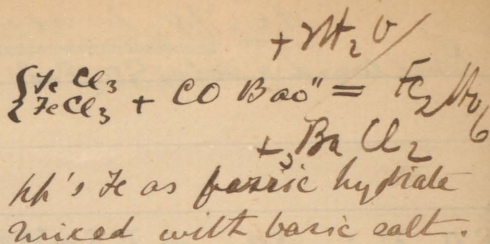
a fine blue pp of ferrous ferric
cyanide, the same in colour
as prussian blue

colours the sol greenish brown



{ Fe^{II} Cl₃ / Fe^{III} Cl₃ } + 6 K₄ Cy₆ = 2 Fe^{II} Fe^{III} Cy₆ + 6 KCl
intense blood red colouration
very delicate test. In very dilute
sols, best to add HCl & other which
dissolves Fe^{II} Cy₆ + float on top.

$SO_2 FeO'' + CO Bao''$ gives no pp.

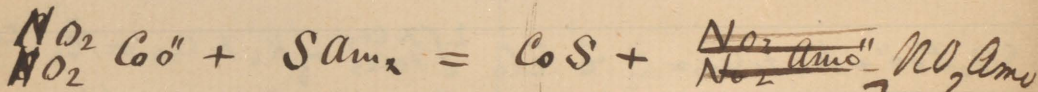


Cobalt Co 58.8.

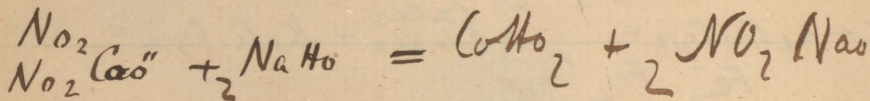
Co with borax bead ($B_4O_5 \cdot Na_2O$) gives a splendid blue bead.

Wet reactions.

Employed a sol of Cobaltic nitrate CO_2, CoO''



insol in acids alkalis, & sol with great difficulty in acids. Black pp.



a blue pp of basic salt insol in excess turns greenish-white on exposure to air, by absorption of O
If boiled it changes to hydrate ($Co H_2O_2$) greyish brown
If before boiling alcohol be added it changes to red-brown hydrated sesquioxide.

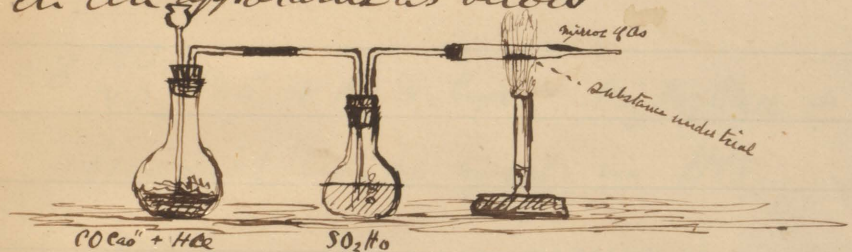
Group II.

Arsenic 75, As

Dry Reactions

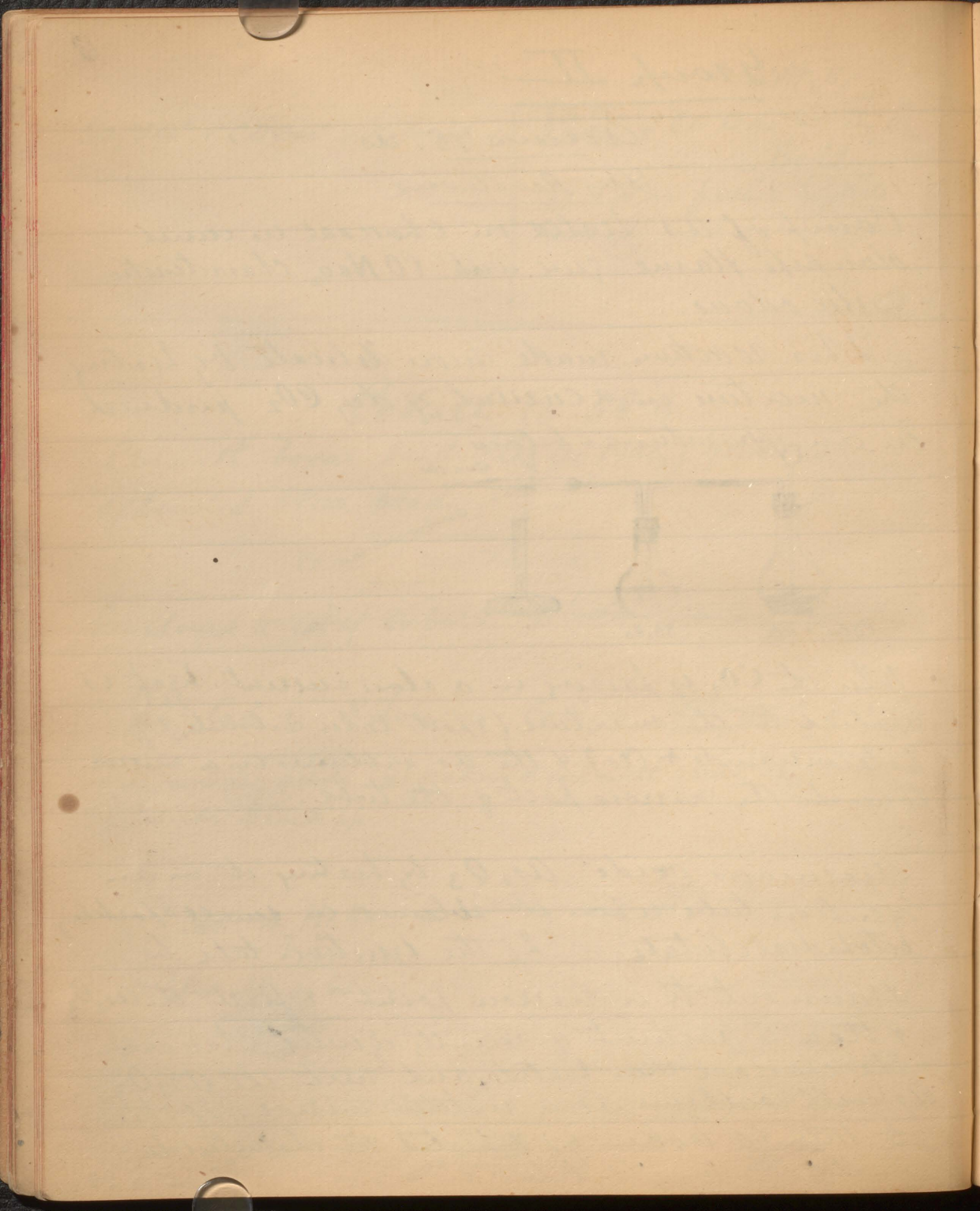
Comp of As heated on charcoal in inner blowpipe flame give with CO NaO_2 characteristic garlic odour.

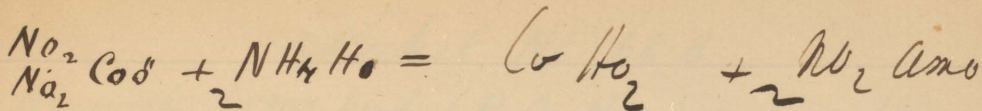
This reaction made more delicate by heating the mixture in a current of dry CO_2 produced in an apparatus as below



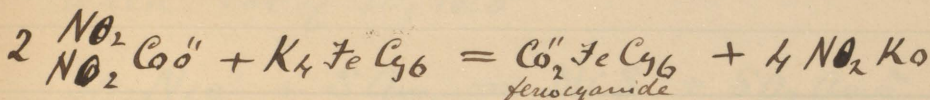
When the CO_2 is passing in a slow current heat is applied to the mixture (3 parts sodic carbonate, 1 of potassic cyanide + As) & the As sublimes in a mirror towards the narrow part of the tube.

Arsenious oxide As_2O_3 by heating it in an ignition tube when it sublimes in small sparkling octohedral crystals. If the ignition tube be drawn out to a narrow point & first the As_2O_3 & then a fragment of recently ignited charcoal. The charcoal then heated, and next the As_2O_3 As will sublime as a metallic mirror. If then the tube be broken off & heated the characteristic smell of As may be detected.

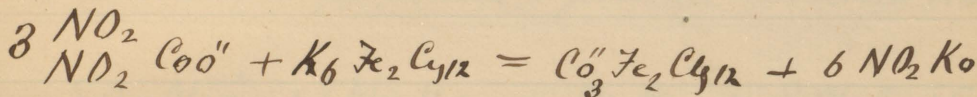




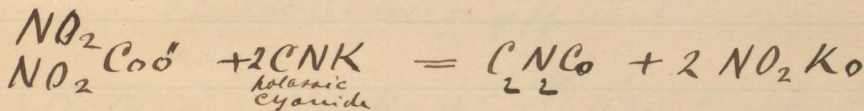
blue/lt basic salt readily sol in excess of ppt'ant to reddish sol, which turns brown from exposure to air. NaHO reprecipitates part of the Co from this sol.



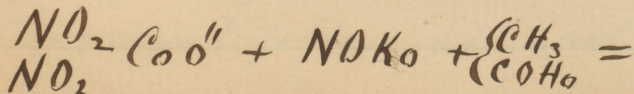
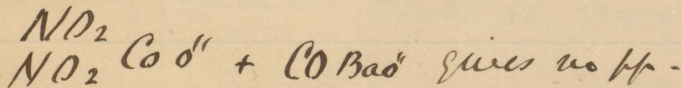
bulky green ppt insol in HCl



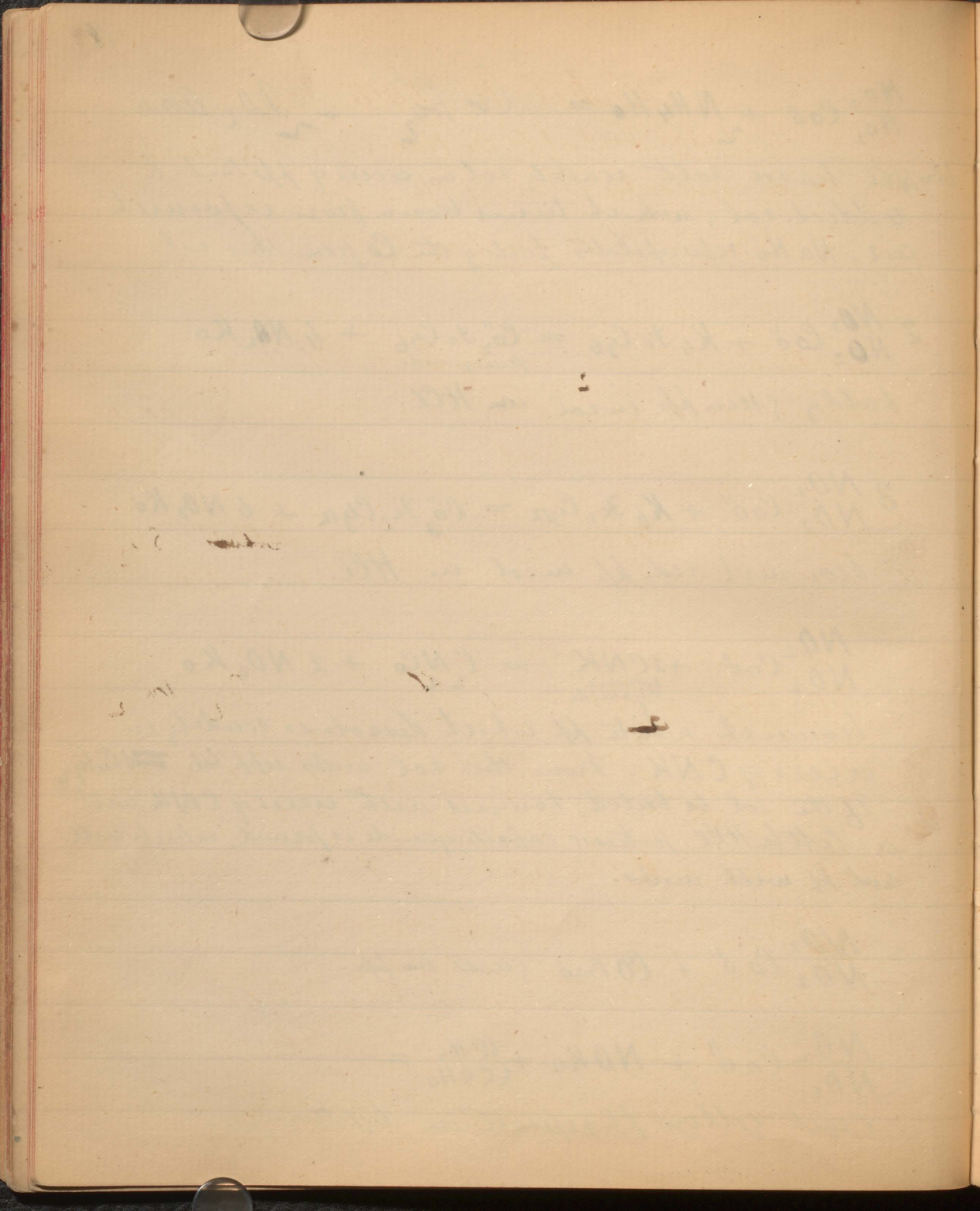
brownish red ppt insol in HCl.



brownish white ppt which dissolves readily in excess of CNK. From this sol acids repp'tate ~~the~~ Co_2 . If the sol be boiled, however with excess of CNK with a little HCl potassic cobalticyanide is formed, which will not ppt with acids.



crypt yellow ppt reprecipitates on digestion.



Nickel Ni 58.8

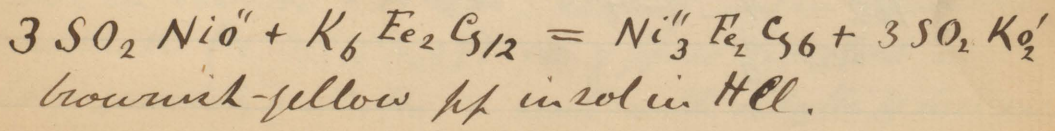
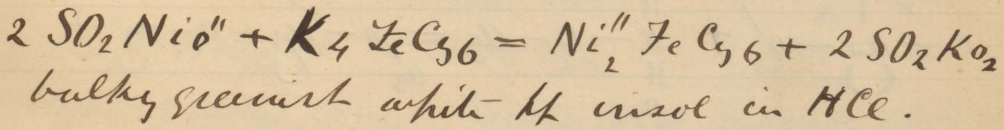
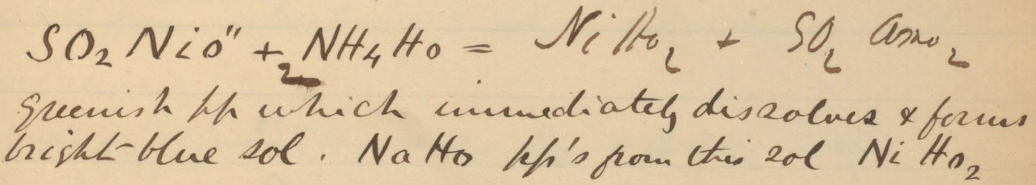
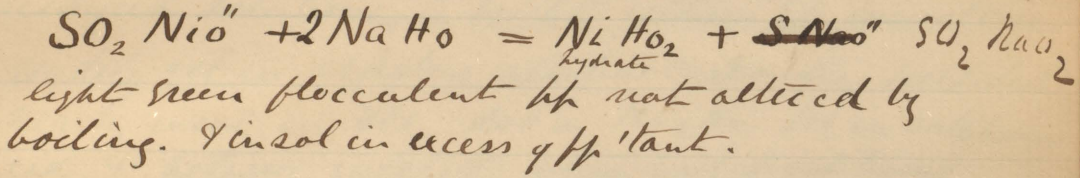
Ni with borax bead ($B_2O_3-Na_2O$) gives a brownish red bead in outer flame of bp

Wet reactions.

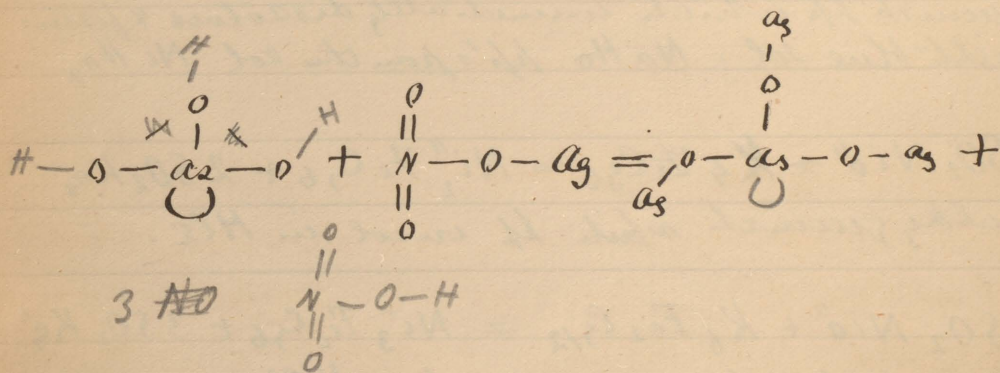
Used sol of $SO_2 NiO''$



Dense black bp sol in excess of bp'tant, as if excess H added, & bp filtered. filliciate coloured brown.



✓



$SO_2 NiO'' + CO Bao''$ gives no ppt

$SO_2 NiO'' + NO Ko + \begin{cases} COH_2 \\ COH_0 \end{cases}$ gives no ppt.

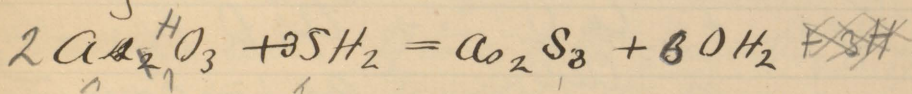
Group II division II.

Arsenic As 75

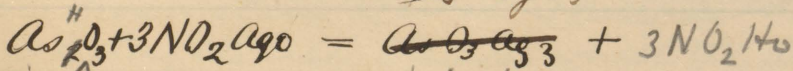
Wet reactions.

Arsenic acid As_2O_3

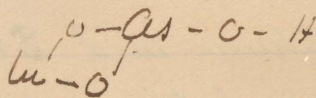
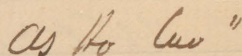
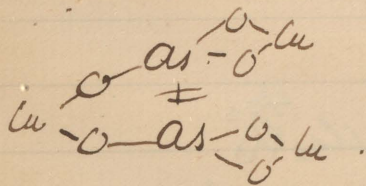
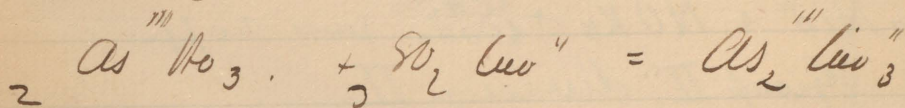
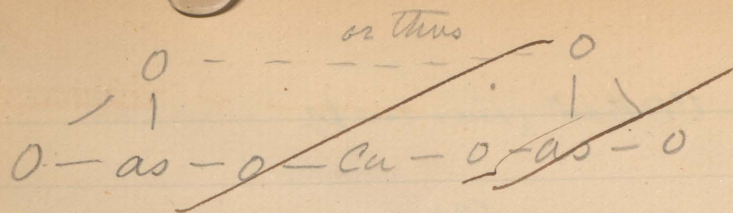
Hydrosulphuric acid H_2S gives with As_2O_3 in acidified solutions, a bright yellow ppt. forms at once, readily sol in alkalis, alkaline carbonates, sulphides &c. nearly insol in HCl. Sol in $NO_2 Ho$. Sol in sulphurous acid, & potassic sulphite. When boiled sol turns turbid from separation of S which redissolves on continued boiling.



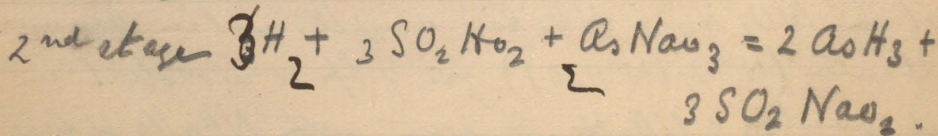
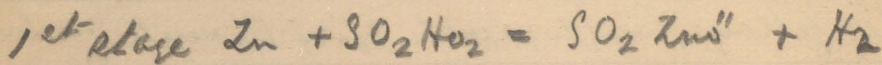
As As_2O_3



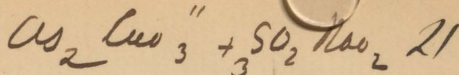
Bright yellow, tough, curdy ppt of Arsenite of silver sol in $NO_2 Ho$ & $NH_4 Ho$. slightly sol in Ammoniac nitrate ($N^o O_2, N^H H_4 O$) for ppt to be dissolved in large quantity of $NO_2 Ho$, & heat with $NH_4 Ho$ ppt does not reappear. If sol in $NH_4 Ho$ be boiled Ag separates as mirror on glass, & powder.



- (1) $\text{As}^{\text{III}} \text{K}_3 + \frac{1}{3} \text{K}_2\text{O} = \text{As}^{\text{III}} \text{K}_3 + 3 \text{OH}^-$
- (2) $\text{SO}_2 \text{Cu}^{\text{II}} + \frac{1}{2} \text{K}_2\text{O} = \text{Cu}^{\text{II}} \text{K}_2 + \text{SO}_2 \text{K}_2$
- (3) $\text{As}^{\text{III}} \text{K}_3 + \text{Cu}^{\text{II}} \text{O} = \text{As}^{\text{III}} \text{O} \text{K}_3 + \text{Cu}_2\text{O}$
CuO Potassic arsenate



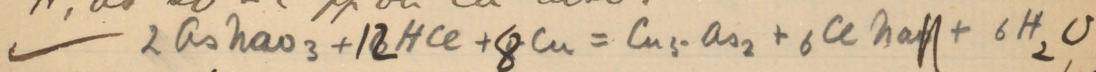
2 AsNaO₃



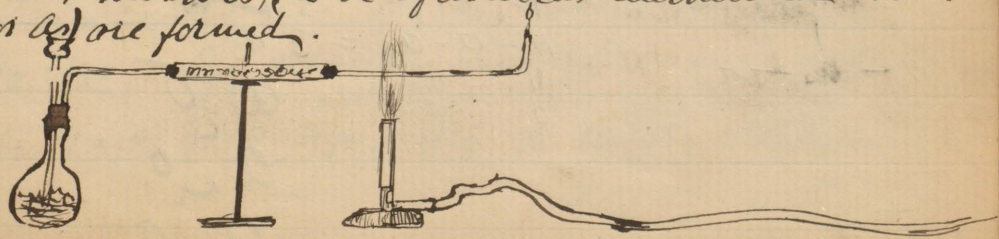
given by arsenite copper (cherry green)

If to sol of AsHPO₃ with excess of OKH, SO₂ CuO'' be added it gives a blue sol, which on boiling deposits red ^{oxide} of Copper (Cu₂O)

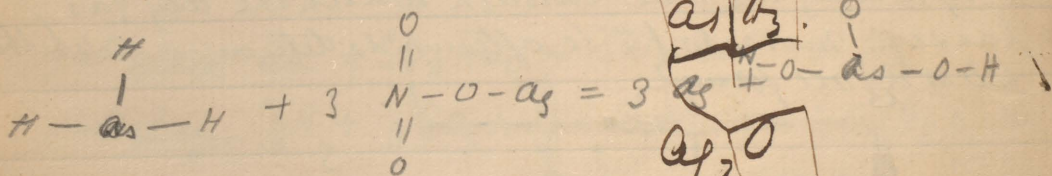
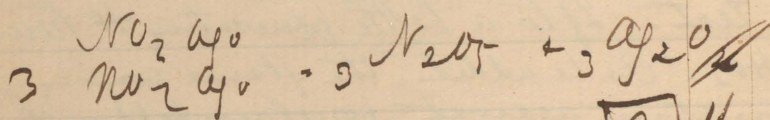
Reinsch's test If to a sol of AsHPO₃, HCl be added, & the mixture heated, with a clean slip of Cu in it, a grey film of Cu₂-As₂ forms on it. If the Cu washed & heated with NH₄HO the film comes off in shingles. Delicate but not decisive unless As be found in the film when heated in current of H₂ as Sb & C ff on Cu also.



Marsh's test. If to a bottle generating H from Zn & SO₂H₂O. As be added the flame coming of it gives brown stain against porcelain held in it & by heating the tube through which the dry gas passes, mirrors, (to be afterwards determined whether Sb or As) are formed.



✓



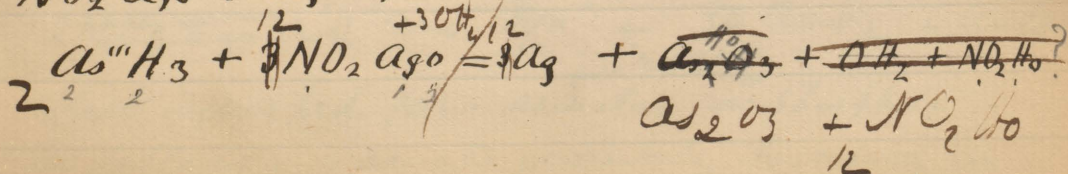
+ ?

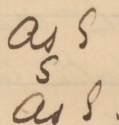
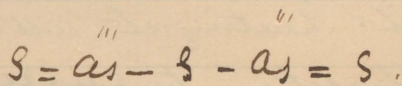
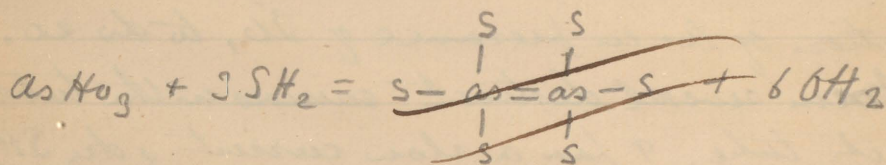
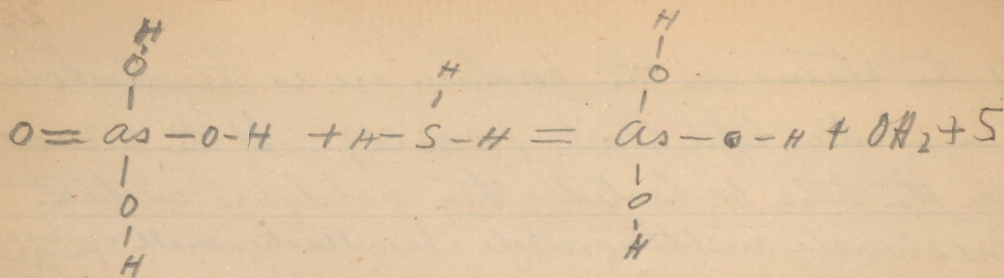
If the stains on the porcelain are as they dissolve in sodic hypochlorite (O Na Cl). If the mirrors in the tube be heated they volatilize without previously melting, while characteristic smell evolved at ^{the same} time. These reactions sometimes inadequate to the detection of As in presence of Sb, to do so.

From several distinct mirrors in the tube, detach tube, & pass a slow current of dry $S H_2$ through it heating it with lamp, moving in opposite direction to current of $S H_2$. If Sb alone present orange or black Sulph of Antimony formed if both As & Sb, both sulphides form arsenic yellow, more volatile in advance.

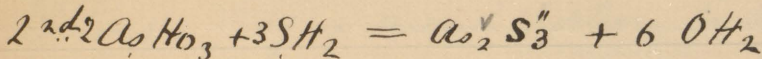
Now transmit dry HCl. If As it remains if it is carried off in the gas, thus separated, & tube containing As filled with $N H_4 H O$ which dissolves sulphide of Arsenic, & thus distinguishes it from any S which may have separated.

If H containing $As''' H_3$ be passed through soft of NO_2 AgO. As separates and As remains, as $As_2 O_3$

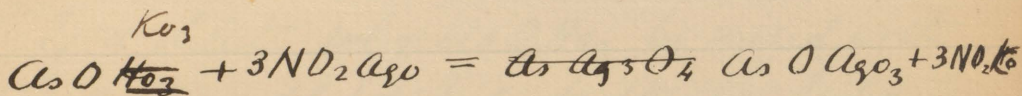




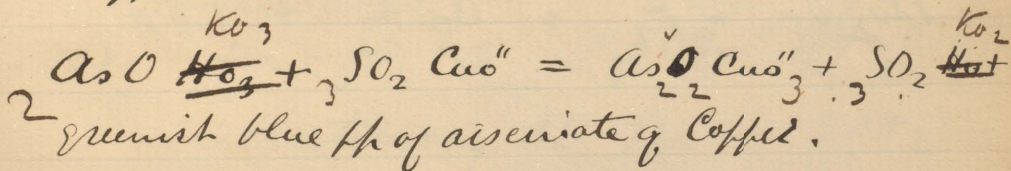
Arsenic Acid. AsO₂H₃



The yellow sulphite + S, in dilute sols takes a long time to fall.

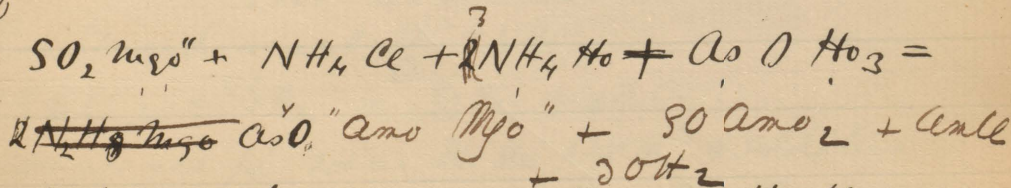


reddish brown pp of arseniate of silver. sol in $\text{NO}_2\text{H}_2\text{O}$ & $\text{NH}_4\text{H}_2\text{O}$. slightly sol in ammoniac nitrate thus if a little ppt be dissolved in a large quantity of $\text{NO}_2\text{H}_2\text{O}$ & neut with $\text{NH}_4\text{H}_2\text{O}$ it often fails to cause ppt.

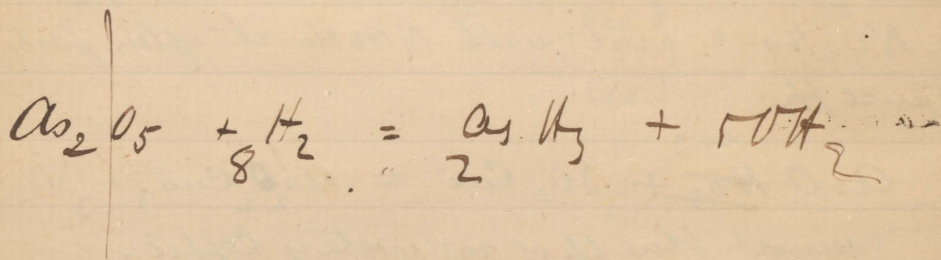


greenish blue pp of arseniate of Copper.

Magnesian sulphate + Ammonic chloride + Ammonic hydrate. gives crypt pp of arseniate of ammonium & magnesium



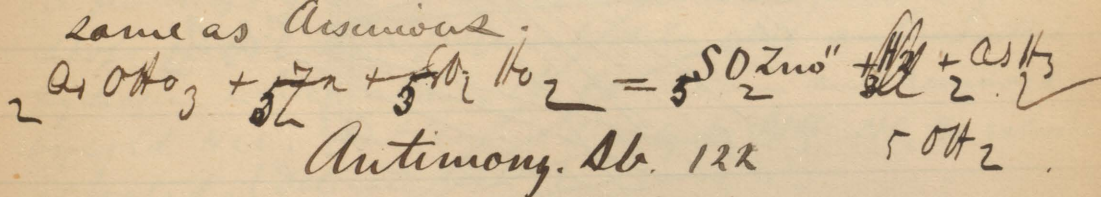
distinquished from similar phosphate as follows. a small quantity dissolved in



$AsO_3 + 3NO_2 Agp = AsO_3 + 3NO_2$
 NO_2, H_2O & $NO_2 Agp$ & sol touched with drop
 of NH_4HO . a brownish red pp of arseniate of
 silver. If a second portion be dissolved in HCl
 & SH_2 passed into the sol, kept warm. yellow
 pp forms.

If a dilute sol of AsO_3 be mixed with
 HCl & Cu added it keeps bright when heated
 but if mixed with two vols of HCl the grey film
 forms. $2AsO_3 + 2Cu + 2HCl = As_2 + 2CuCl_2$
 $+ 2OH_2$

With Zn & SO_2, H_2O arsenic solutions fact the
 same as Arsenious.



Dry reactions

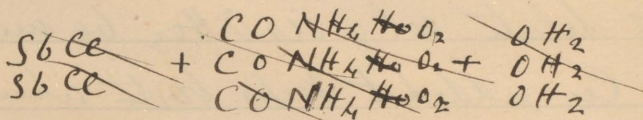
Comps of Sb heated in reducing flame of bp
 with CO NaO_2 give little bit of globules of metallic Sb.

Wet reactions.

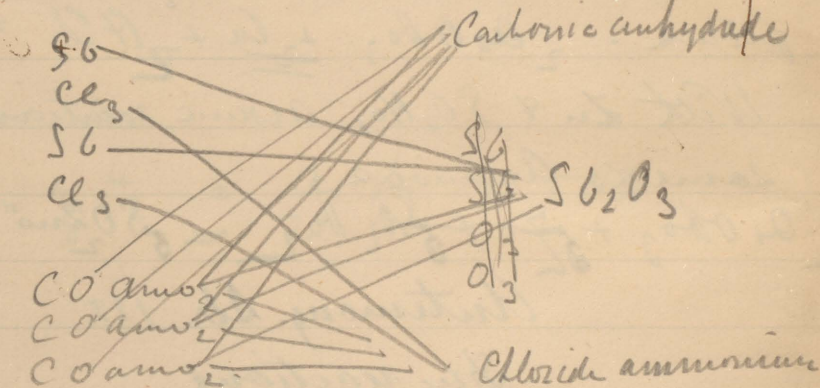
Employed a sol of $SbCl_3$

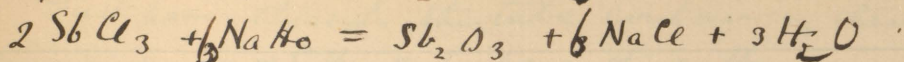
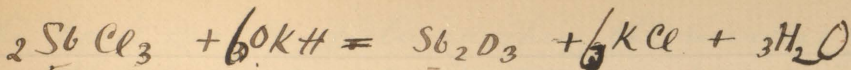


an orange red pp sol in $NaHO$, OKH , & alkaline
 sulphides. Sparingly sol in NH_4HO . Insol in dilute
 acids. Sol in strong HCl .

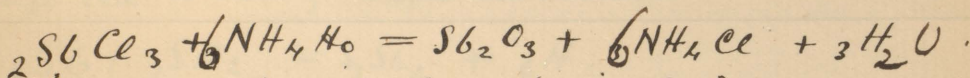


Amo
Amo

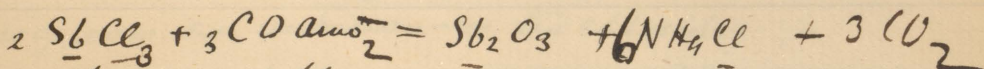




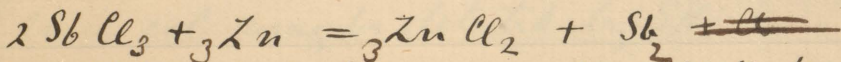
white flocculent H_2 redissolves in excess.



same as last. Almost insol in excess.

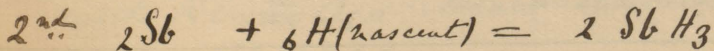
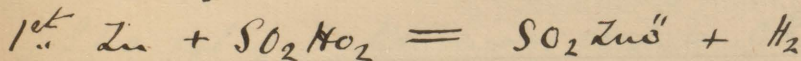


The same H_2 .



Sb ppt'd as black powder if H_2 NO_2 HO be absent a few drops of sol of Sb on Platinum, with a few drops of HCl & a fragment of Zn , give antimoniated hydrogen, which stains the Pt . Stain not removed by cold HCl . But immediately by ~~H_2~~ NO_2 HO especially if heated. (Delicate test.)

If a small quantity of Sb sol be put into an apparatus evolving H_2 (like that described for As on P 21) the gas burned from a jet stains porcelain mirrors of Sb can also be formed in the tube

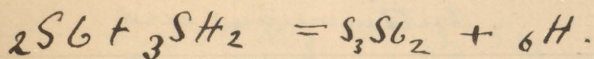


The stain of Sb on porcelain may be distinguished from that of As , by its insolubility in ONaCl / (soluble H_2 / precipitated)

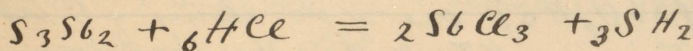
Aboko
[0]

ay2 0
ay2 [0]

The best way of distinguishing the mirrors of Sb from As is. First pass through the tube containing them a slow current of SH_2 & heat with a flame in opposite direction from current. Sb changes into S_3Sb_2 an orange red to nearly black substance.

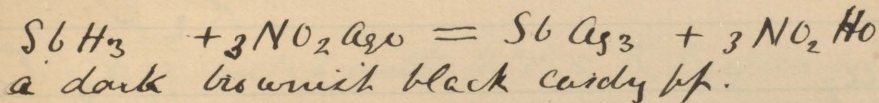


Then pass current of dry HCl S_3Sb_2 is volatilized & disappears as antimonious trichloride.

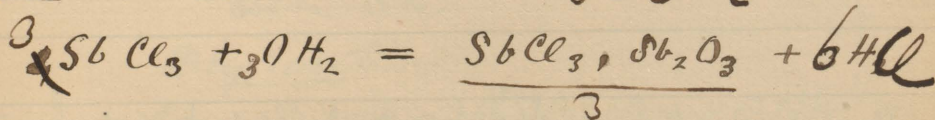


If the gas be conducted into water the presence of Sb in sol may be detected by SH_2

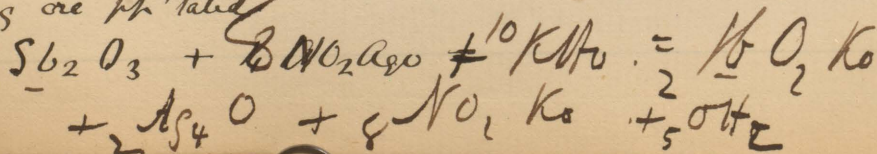
H + SbH_3 passed through sol of NO_2 Agp ph's
~~metalloid~~ Sb as SbAg_3

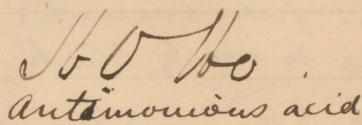
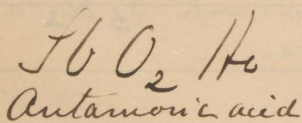
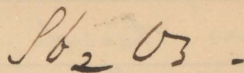
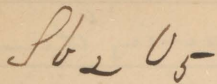


OH_2 ph's from strong sols of Sb a ph of basic salt. thus.



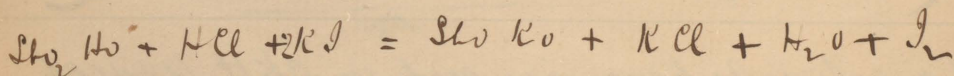
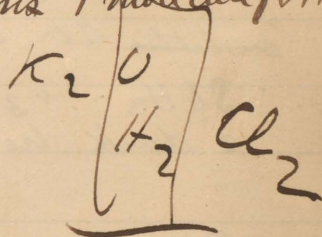
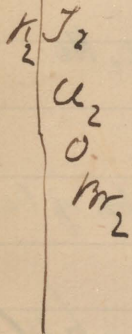
If a sol of antimonious oxide in OKH be mixed with NO_2 Agp. Black suboxide & grey-brown oxide of Ag are ph'tated



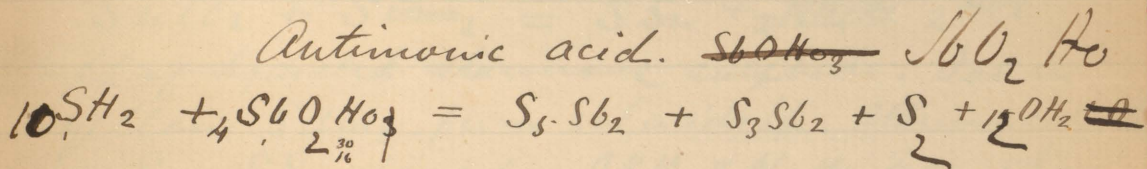


Antimonious may be distinguished from antimonious by the reaction with KI & HCl. When Antimonious acid is used ($SbO_2 Ho$) one of its atoms of O takes the place of the I in $2KI$ & the Ko thus formed immediately combines with the ~~antimonious~~^{HCl} acid.

Two molecules of KI are employed, & 1 mol of I_2 liberated & the other of K unites with the HCl forming HCl. The Hydroxyl liberated by K from $SbO Ho$ takes the H liberated from the HCl by K and forms 1 molecule of H_2O

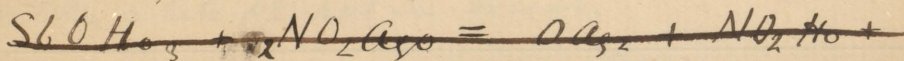


No Iodine is liberated when Antimonious oxide
 Sb_2O_3 is boiled with HCl & KI .

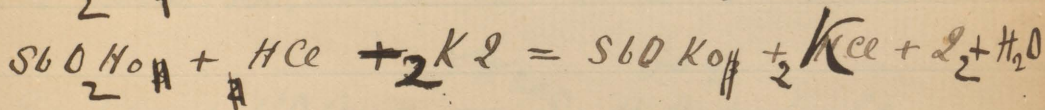


With Zn & H gas ature Antimonic acid behaves, as
 antimonious acid did.

If a sol of SbO_2HO in OKH be mixed with NO_2 gas
 no sub-oxide of As is left-behind.



SbO_2HO boiled with HCl & KI give free I



Zin Sn.

Dry reaction

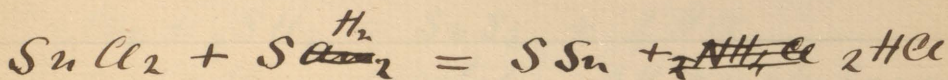
Corrupt of Sn , mixed with CO Nao & CNK , or
 Charcoal before bf give malleable globules of
 metallic Sn .

NH4D

Dyad

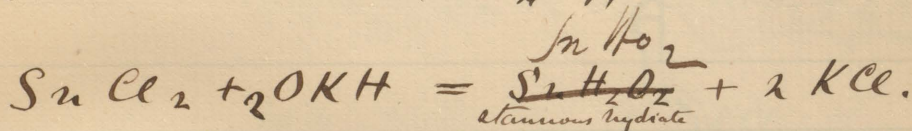
~~Tetrad~~ tin. Sn^{II}. Wet reactions

Employed a sol of Sn Cl₂

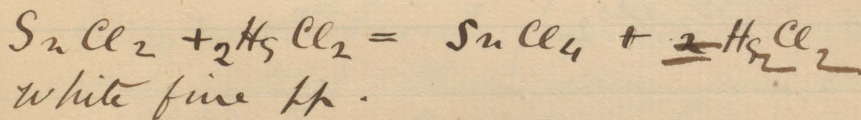
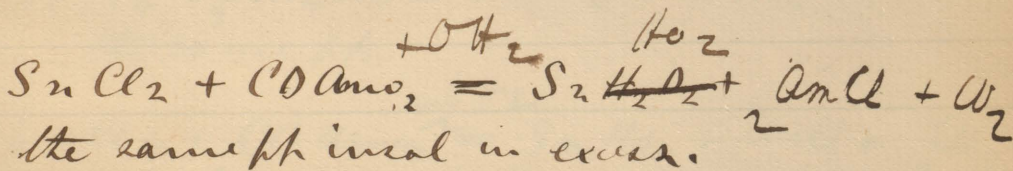
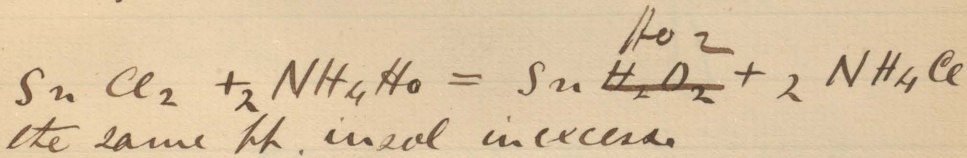


pp of hydrated stannous sulphide. Sol in yellow SAm₂, from sol acids pp. Stannic sulphide + S. S Sn also sol in OKH & NaHO from this sol acids pp taste stannous sulphide.

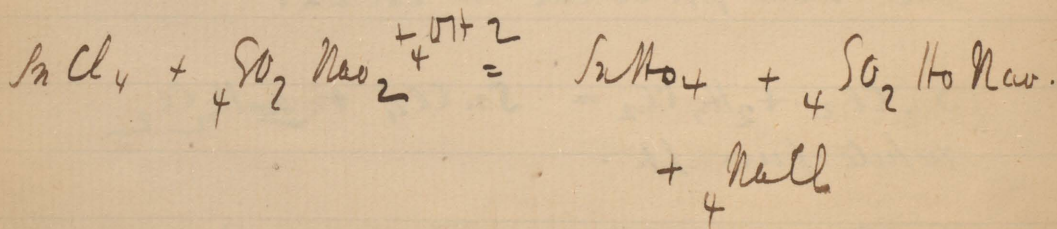
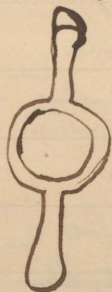
Sol in boiling HCl. Changed by boiling NO₂HO into metastannic acid (Sn H₄ O₄).



bulky white pp sol in excess.

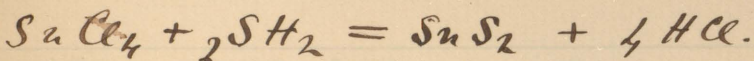


Sn Cl₂ + Zn = Zn Cl₂ + Sn
Metallic tin in a spongy mass.



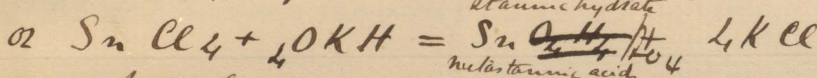
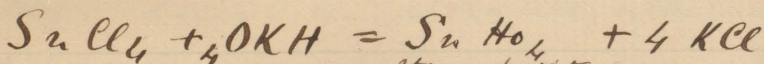
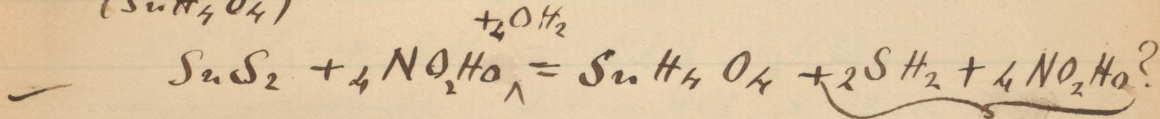
Tetra Sn^{IV}

Used a sol of SnCl₄



light-yellow pp. Sol in OKH alkaline sulphates.
boiling HCl & aqua regia. also in SAm_2 , from
this sol acids pp' late stannic sulphite unaltered.

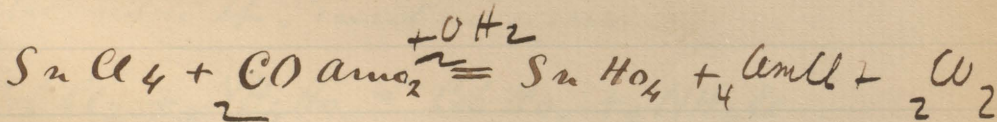
Concentrated NO_2Ho changes it to metastannic acid
(SnH_4O_4)



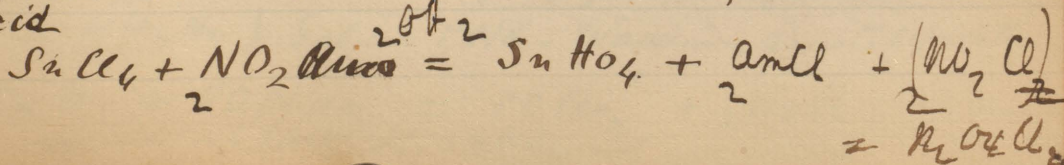
white bulky pp. sol in excess.



the same pp.



Nitrate of ammonium, (or almost any salt of
the alkali metals) thrown down from sols of
both stannic comp's. stannic hydrate, or metastannic
acid



1870

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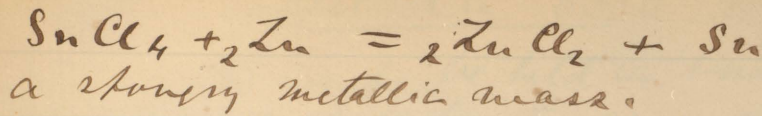
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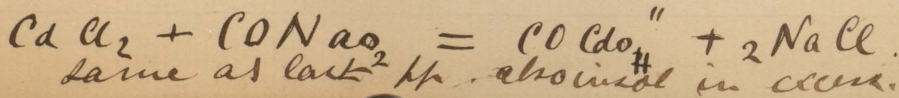
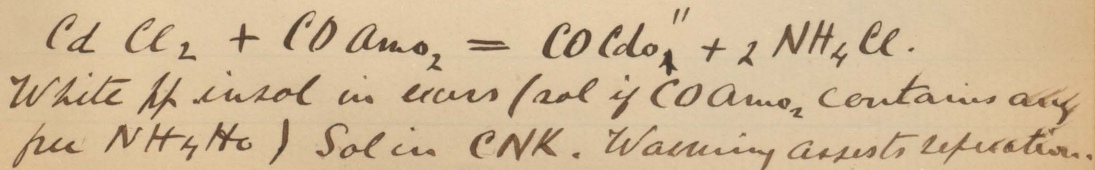
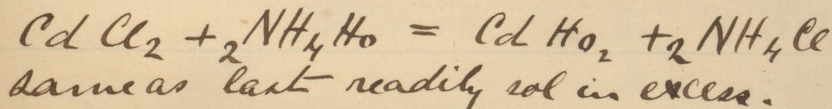
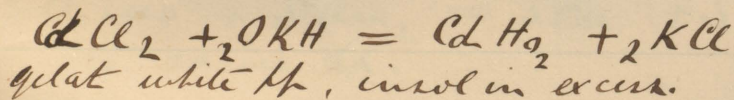
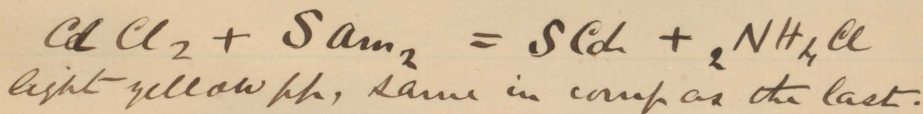
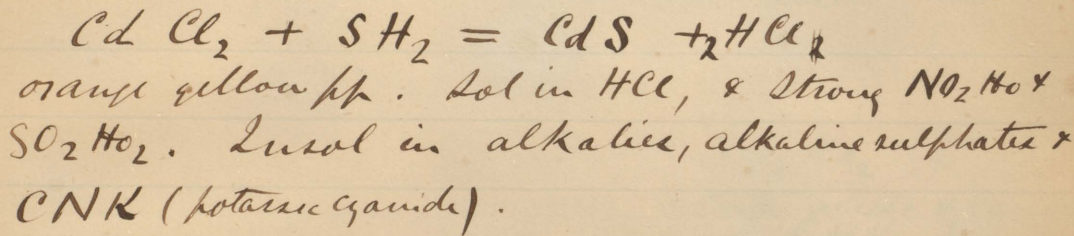
1870



Group II Division I.

Cadmium Cd.

Employed a sol of CdCl_2 .



Group II. Division I

Division II

1. $2H_2 + O_2 = 2H_2O$

2. $2H_2 + O_2 = 2H_2O$

3. $2H_2 + O_2 = 2H_2O$

4. $2H_2 + O_2 = 2H_2O$

5. $2H_2 + O_2 = 2H_2O$

6. $2H_2 + O_2 = 2H_2O$

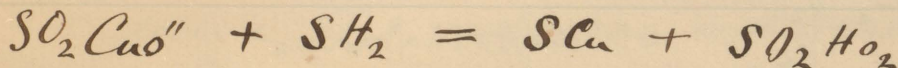
Copper Cu 63.5

If Cu or its comps be held in bunsen flame beautiful & characteristic green colour is observed. If HCl added it is a very blue green. (Delicate lily)

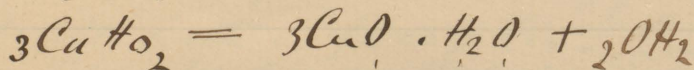
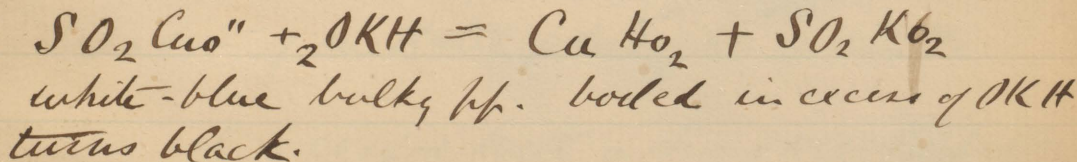
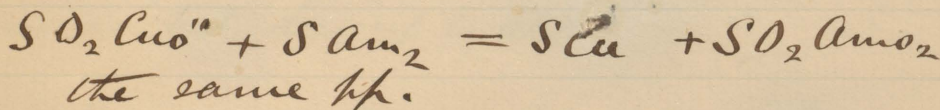
Comps of Cu with CNK & CO NaO₂ give, on charcoal in the reducing flame metallic Cu.

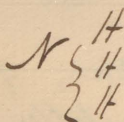
Cu with Borax bead (B₄O₅-NaO₂) in outer flame of bp gives a green bead when hot blue when cold.

Wet reactions

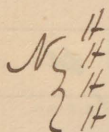


brown black bp. Insol in dilute acids & caustic alkalis. Sol in boiling NO₂HO & CNK. Not acted on by boiling dilute SO₂HO₂.

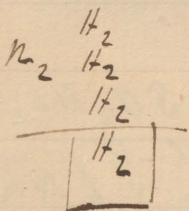




Ammonia

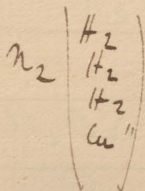


Ammonium (hypoth. metal)

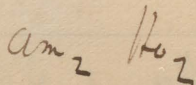


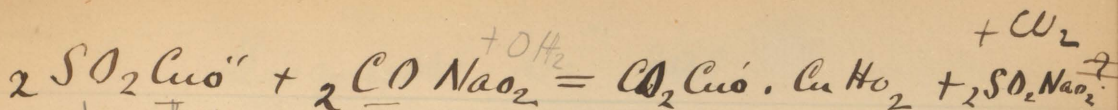
Cu^{II}

cuprammonium

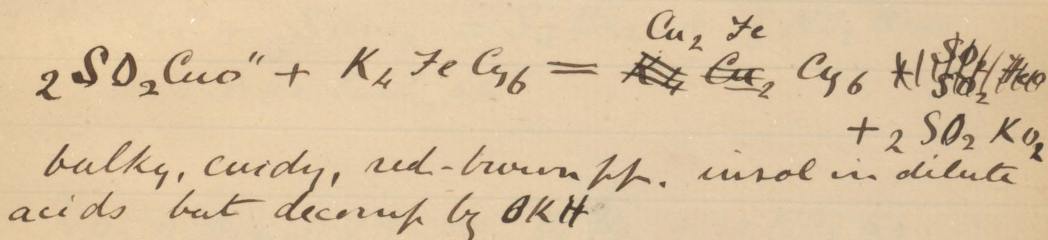
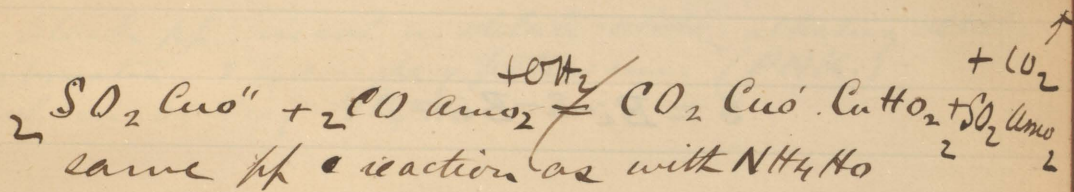
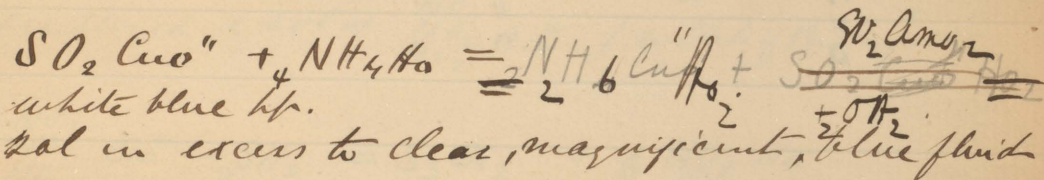


H₂O





greenish blue ^{1/2} of basic carb of Cu. when boiled changes to brown-black hydrated oxide. Sol in NH_4HO to azure & CNK to clear liquid.



Deposit of metallic film of Cu on the Fe

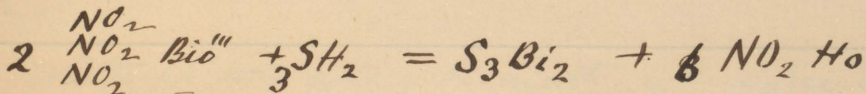
If a sol of copper with a drop of HCl be put on Pt-foil with a piece of Zn. Cu is deposited on the Pt. (Delicate test.)

Bismuth, Bi^{III} 208.

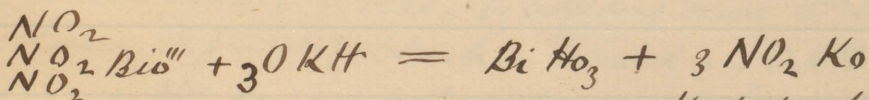
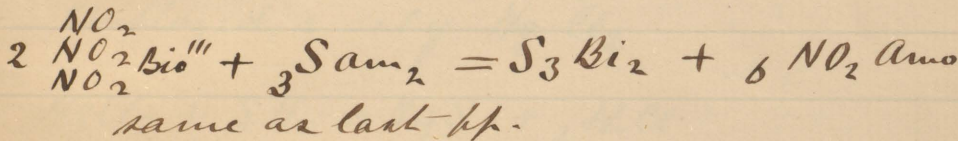
Corrupts of Bi with CO ~~and~~ Na₂ on charcoal, in reducing flame give, beads of metallic Bi.

Wet reactions

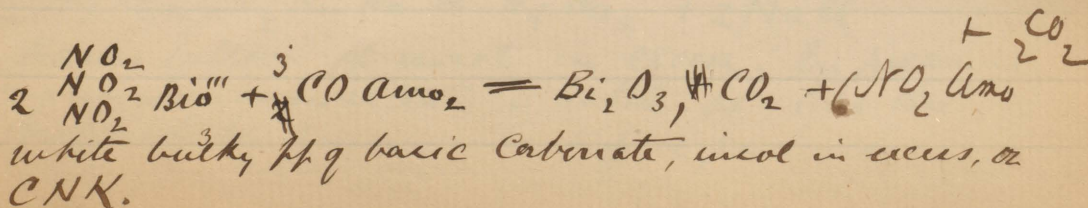
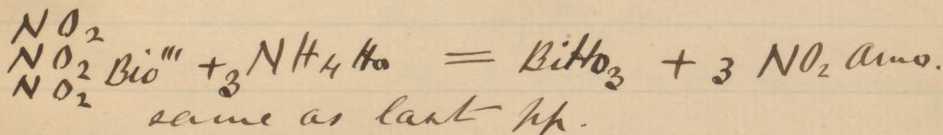
employed a sol of $\begin{matrix} \text{NO}_2 \\ \text{NO}_2 \\ \text{NO}_2 \end{matrix} \text{Bi}^{\text{III}}$ / nitrate of Bismuth

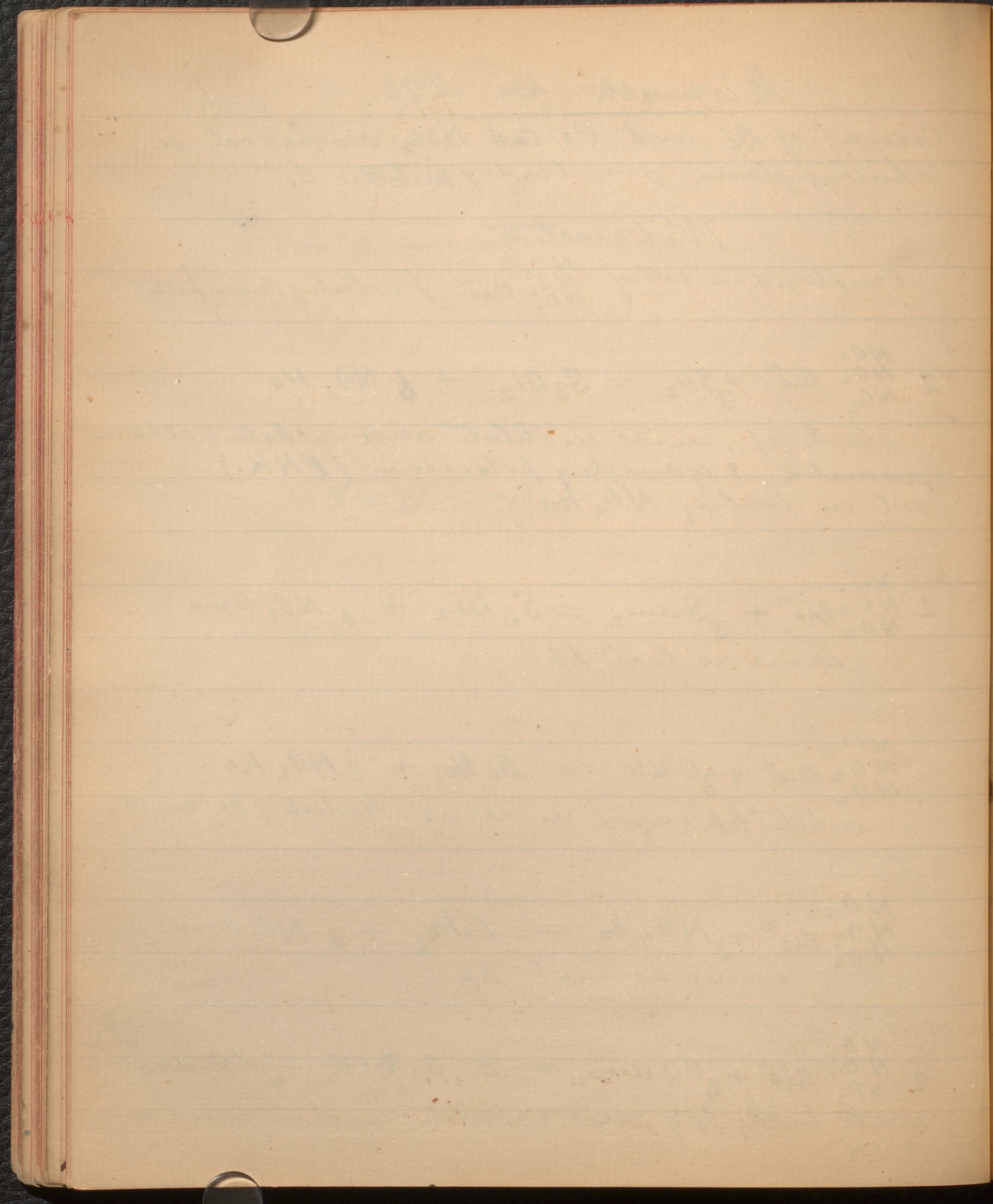


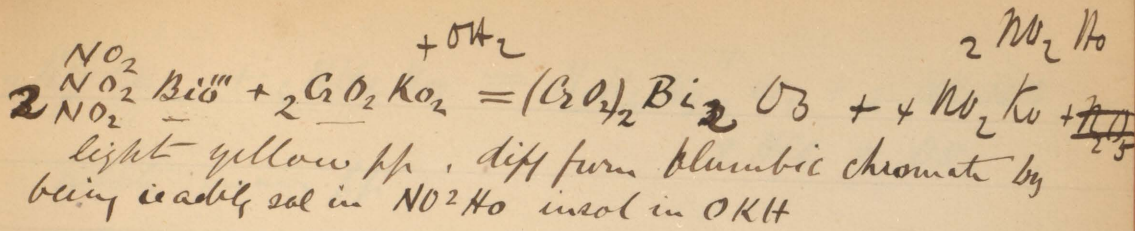
black ppt, insol in dilute acids, alkalis, alkaline carbonates, & cyanide of potassium (CNK.)
sol in boiling NO₂ H₂O.



white ppt insol in excess. Hydrate of bismuth.





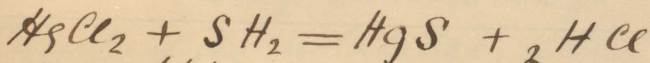


Dilute $\text{SO}_2 \text{H}_2\text{O}$ does not pp 'tate sols of Bi

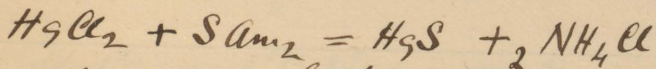
Water pp 'tates sols of bismuth, when free acid not present (most sensitive with chloride)

Dyad Mercury Hg 200

Employed a sol of Hg Cl_2



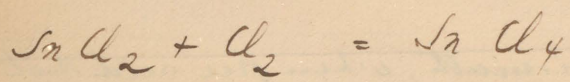
on adding a small quantity of the pp 'tant the pp comes down white, by adding more it becomes yellow, & finally black. insol in OKH & CNK HCl & $\text{NO}_2 \text{H}_2\text{O}$. sol in potassium soda in sodic sulphide. readily sol in aqua regia.

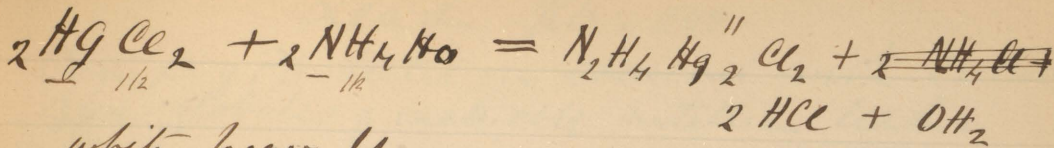


same as last pp, & acts in the same way.

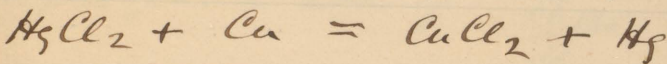


Heavy yellow pp insol in excess. In presence of ammonium salts, a white pp, like that produced by ammonia itself is produced.





Metallic Cu ph' from soln of Hg metallic Hg

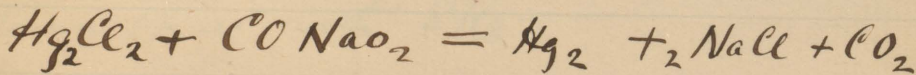


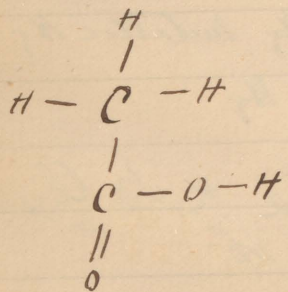
$\text{Hg}_2\text{Cl}_2 + \text{SnCl}_2 = \text{Hg}_2 + \text{SnCl}_4$
 white pp turns grey from ph'tation of metallic Hg
 on continued addition of stannous chloride

Dry reactions for both Hg's

Comp of Hg volatilize when heated in ignition tube.

If anhydrous comp of Hg & CO ~~or~~ NaO₂ be heated in an ignition tube. metallic Hg sublimes, & may be united into distinct globules by breaking off the point of the tube & rubbing.



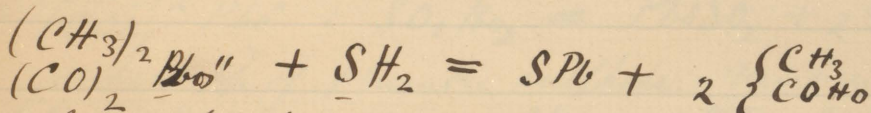


Lead Pb. 207

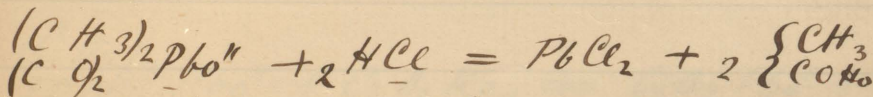
Comps of Pb heated on charcoal with CO Na_2O_2
give globules of malleable metallic lead.

Wet reactions.

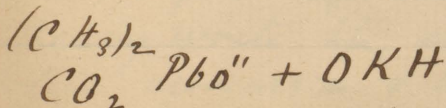
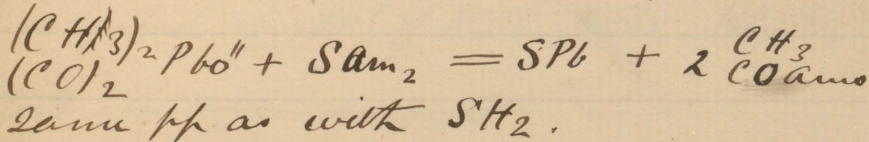
Employed a sol of $\begin{matrix} \text{CH}_3 \\ \text{CO} \\ \text{CO} \\ \text{CH}_3 \end{matrix} \text{PbO}''$ $\begin{matrix} (\text{CH}_3)_2 \\ (\text{CO})_2 \end{matrix} \text{PbO}''$



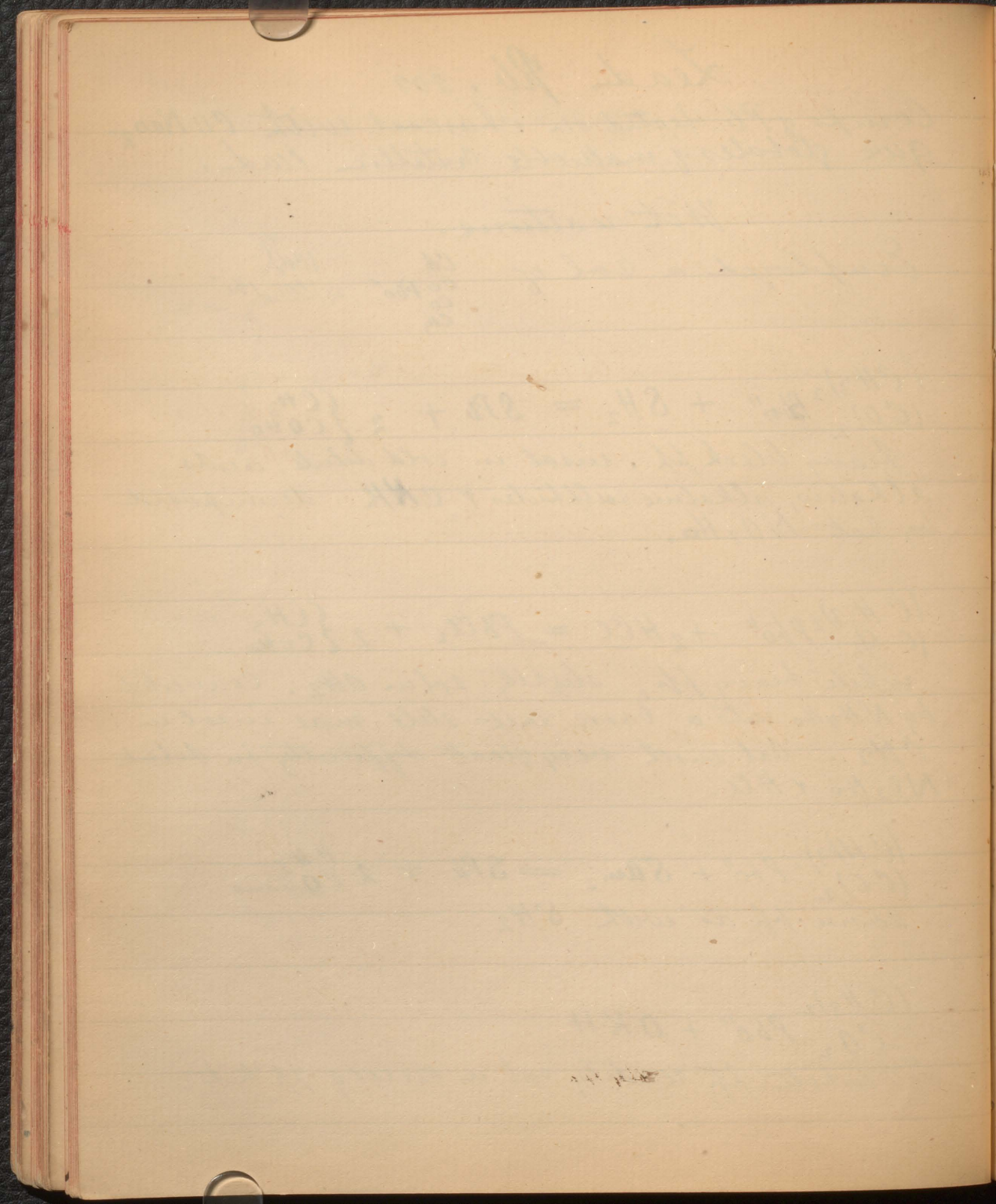
heavy black pp. insol in cold dilute acids, alkalis, alkaline sulphides & CNK . decomposed by hot NO_2HO .

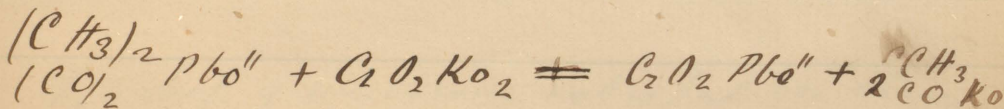
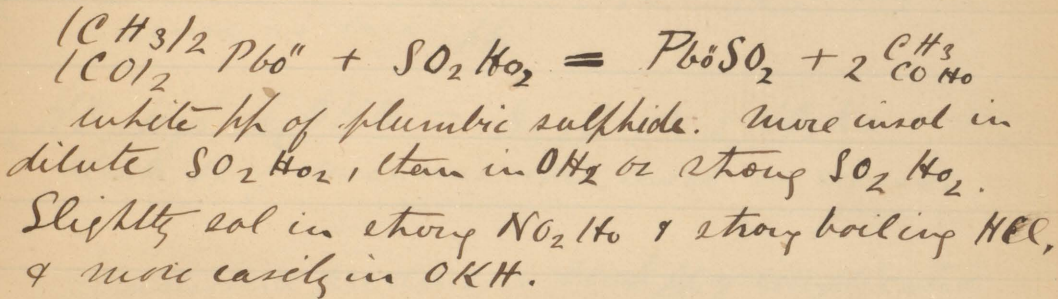
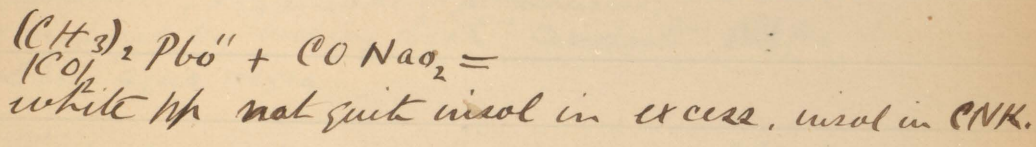
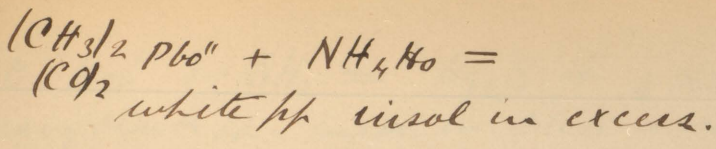


white heavy pp, slightly sol in OH_2 . Converted by NH_4HO into a basic salt still more insol in OH_2 . Sol with very great difficulty in dilute NO_2HO & HCl .



white pp readily sol in excess of pp'tant.

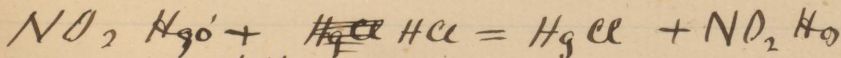
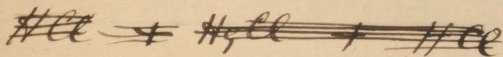




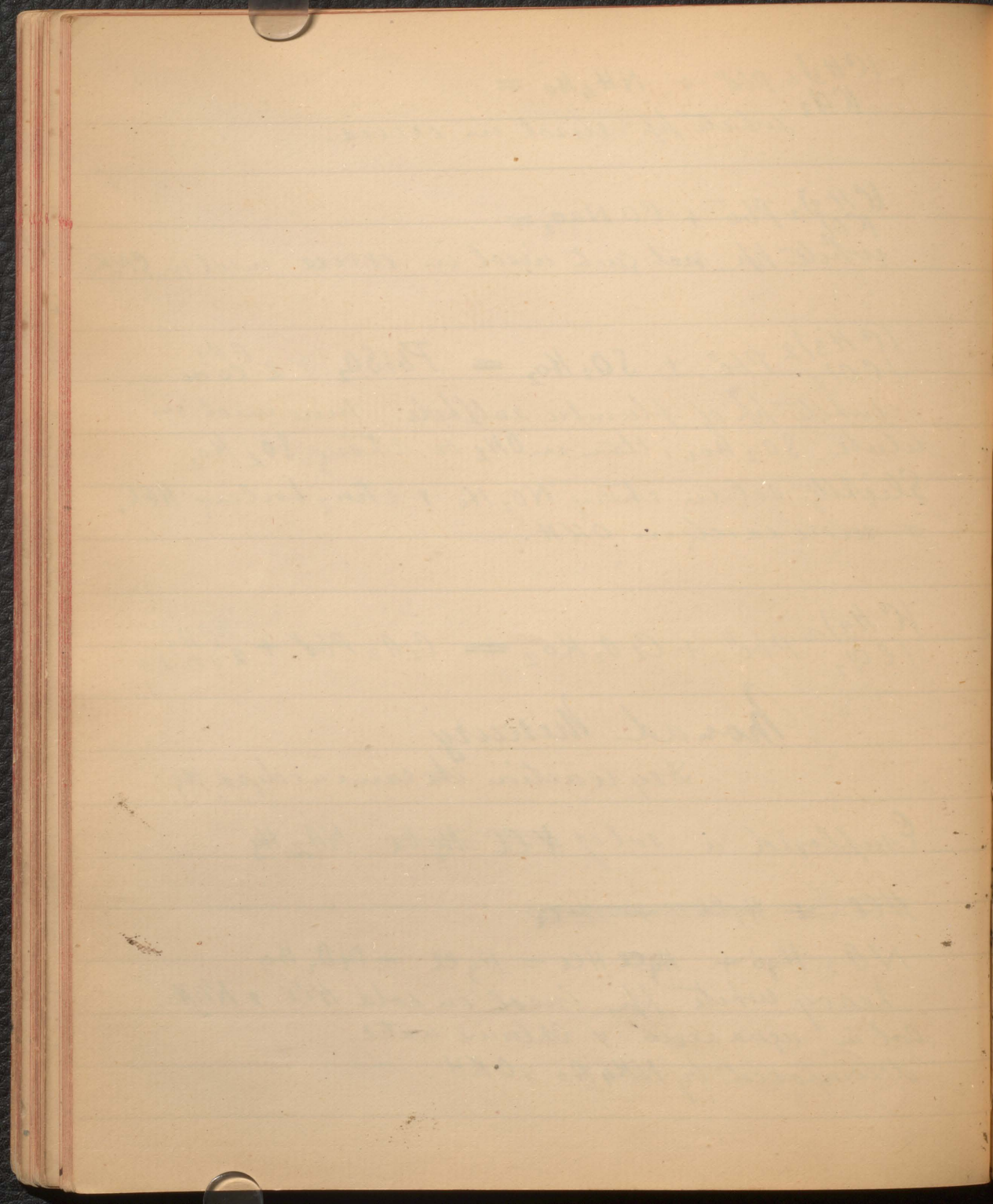
Monad Mercury

Dry reaction the same as dyad Hg

Employed a sol of ~~HCl~~ ~~HgCl~~ $\text{NO}_2 \text{Hg}$



heavy white sp, insol in cold HCl & $\text{NO}_2 \text{HO}$.
sol in aqua regia & Chlorine water,
decomposed by $\text{NH}_4 \text{HO}$ & OKH .



$2 \text{NO}_2 \text{Hg}' + \text{SH}_2 = \text{Hg}_2\text{S} + 2 \text{NO}_2 \text{Ho}$
 heavy black pp. insol in dilute acids, sulfide of
 ammonium, & cyanide of potassium.
 Decomposed by boiling with concent $\text{NO}_2 \text{Ho}$.
 Sol in aqua regia.

$2 \text{NO}_2 \text{Hg}' + \text{SAm}_2 = \text{SHg}_2 + 2 \text{NO}_2 \text{Hgo}$
 same as last pp.

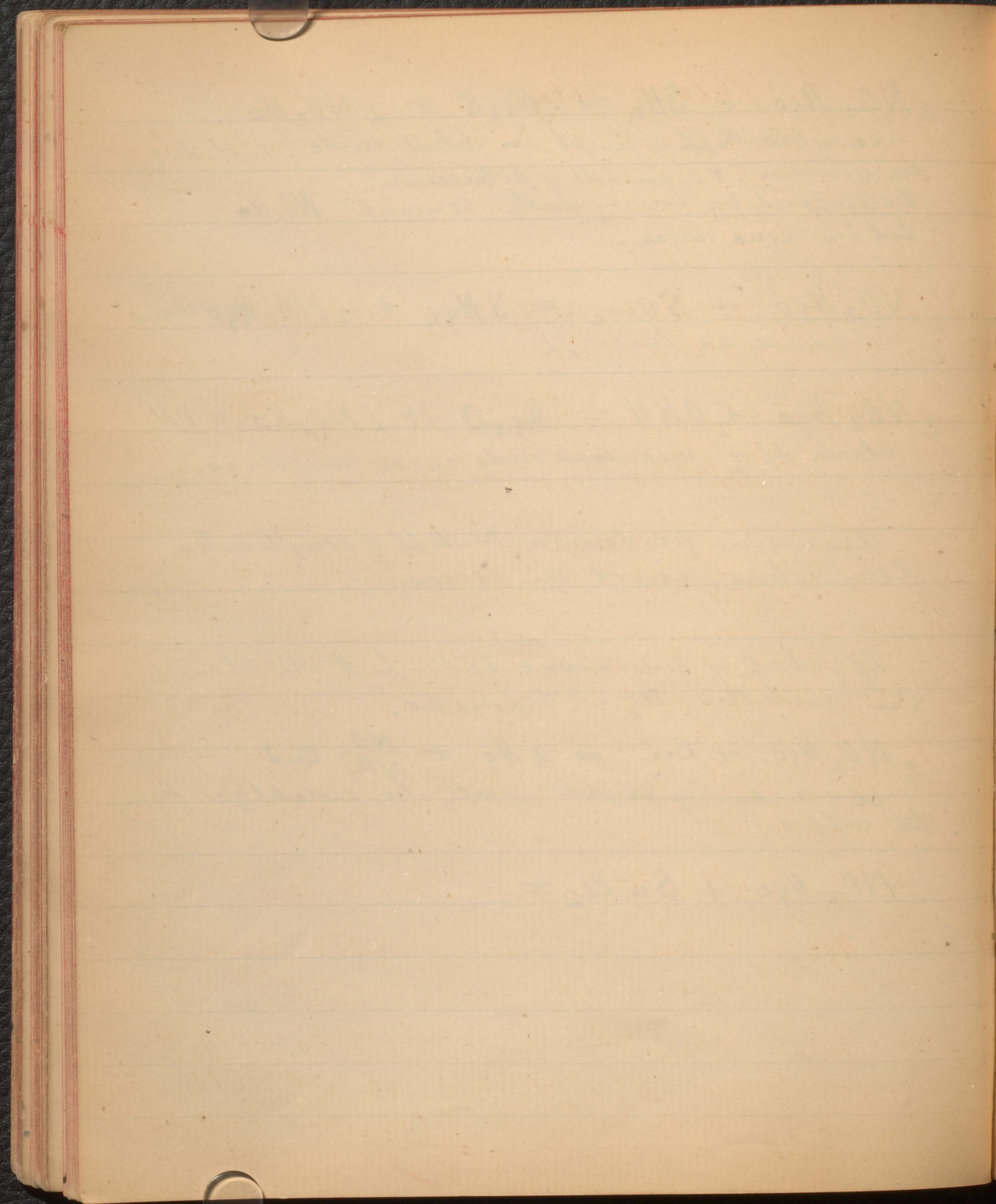
$2 \text{NO}_2 \text{Hg}' + 2 \text{OKH} = \text{Hg}_2\text{O} + 2 \text{NO}_2 \text{Ko} + \text{OH}_2$
 black pp of mercurous oxide, insol in excess.

Ammonia produces a black pp of complicated
 composition, insol in excess.

If a drop of mercurous sol is put on clean
 Cu metallic Hg is deposited.

$2 \text{NO}_2 \text{Hg}' + \text{Cu} = 2 \text{Hg} + \text{NO}_2 \text{Cu}''$
 NO_2
 It may by slight heat, be volatilized, from
 the copper.

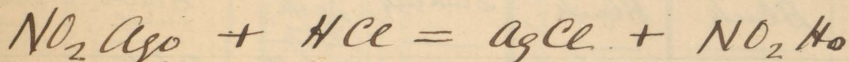
$\text{NO}_2 \text{Hg}' + \text{Sn Cl}_2 =$



Silver Ag

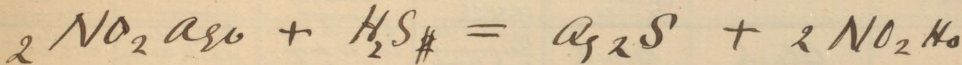
Dry reaction. with CO_2Na_2 before blowpipe flame on charcoal, metallic silver, in smallable globules produced.

Wet reactions.

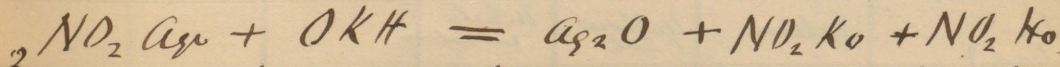
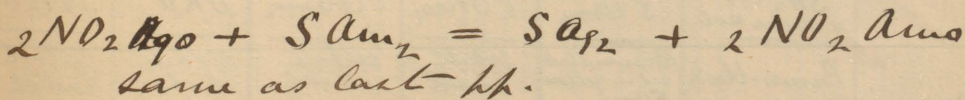
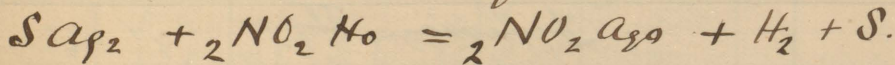


a white, bulky curdy pp. which comes down even in very dilute sols. Changes colour by action of light, first becomes purple, afterwards black. It loses Cl during this change.

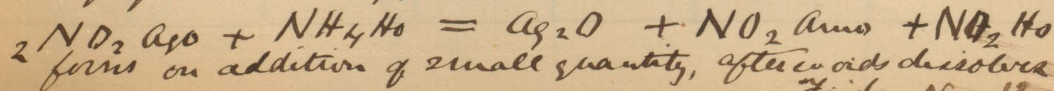
Sol in NO_2Ho , sol in NH_4Ho & reprecip from this sol on addition of an acid. Concentrated HCl & concent sols of ClNa & ClK , dissolve AgCl slightly, reprecip on dilution. When heated fuses to a horny mass (horn silver).



black pp, insol in dilute acids alkalis, * alkaline sulphides, & CNK . Sol in boiling NO_2Ho , with separation of S.



grayish brown pp insol in excess, sol in NH_4Ho



Friday, Nov 12 1869.

Group I.

Metals precipitated by Hydrochloric acid

Names of bases	SH_2 in acidified sol	SAm_2	Carbonate of soda	Ammoniac Carbonate	Potash	Ammoniac
Silver oxide of.	Black.	Black	White insol	White sol	Pale brown insol	Pale brown sol.
Mercurium	Black	Black	Dark grey	Dark grey	Black insol	Black insol
Lead	Black	Black	White insol	White insol	White sol <small>more at first with the acetate</small>	White

Group II metals not precipitated in previous group, but thrown down by SH_2 in presence of a moderate excess of HCl .

Division I.

	SH_2 in acidified sol	SAm_2	CONa_2	COAm_2	OKH	NH_4Ho
Mercurium	White turning to black	White turning to black	Reddish brown insol	White insol	Yellow insol	White insol
Bismuth.	Brown-black	Brown-black insol in excess.	White insol in excess	White insol	White insol	White insol
Copper	Black	Black	Greenish-blue becoming dark brown on boiling	Greenish-blue sol to deep blue sol	Pale blue dark brown when boiled	Pale blue rich blue sol in excess.
Cadmium	Bright yellow	Bright yellow insol in excess	White insol in excess	White insol	White insol	White sol in excess.

Division II.

	SH_2 in acidified sol	SAm_2	CONa_2	COAm_2	OKH	NH_4Ho
Zinc (dry ad.)	Brown-black	Brown-black sol in yellow SAm_2	White insol	White insol	White sol	White insol
Zinc (tetrad.)	Yellow	Yellow sol	White insol			

Group I metals precipitated by HCl.

Base	$S\text{H}_2$ in acidified solution	$S\text{Am}_2$	$\text{CO Na}_2\text{O}_2$	$\text{CO Am}_2\text{O}_2$	OKH	$\text{NH}_4\text{H}_2\text{O}$
Silver Ag. 104.	Black H. insol in dilute acids alkalies alkaline sulfides or CNK. sol in boiling NO_2H_2 with separation of S.	Black H. insol in dilute acids & alkalies alkaline sulfides or CNK sol in boiling NO_2H_2 with separation of S.	White insol	White sol	Ag_2O Greyish-brown H. insol in excess sol in $\text{NH}_4\text{H}_2\text{O}$	Ag_2O Greyish-brown H. which forms on addition of small quantity of HCl. Not on adding more readily dissolved.
Mercurous Hg. 200.	Heavy black H. insol in dilute acids $S\text{Am}_2$ & CNK. Sol in aqua regia Decomposed by boiling with conc. NO_2H_2	Hg_2S Heavy black H. same as with $S\text{H}_2$.	Dark grey	Dark grey	H_2O Black H. of amercurosoxide. insol in excess.	Black H. insol in excess.
Lead Pb. 207.	Heavy black H. insol in cold dilute acids alkalies sulfides & CNK Decomposed by hot NO_2H_2	Heavy black H. SPB same as with $S\text{H}_2$	White insol but quite insol in excess. insol in CNK.	White insol	White H. readily sol in excess.	White H. insol in excess.

Group II.

Metals not precipitated in previous group, but thrown down by SH_2 in presence of a moderate excess of HCl

Division I. insol in SAm_2

Bases	SH_2 in acid sol	SAm_2	CO NaO_2	$\text{CO } \frac{\text{NH}_4}{\text{Am}_2}$	OKH	$\text{NH}_4 \text{HO}$
Magnesium Mg , 200.	Yellowish White flk becoming yellow, often black by continued addition. Insol in OKH , CNK , HCl , H_2SO_4 and in aqua regia.	White flk becoming yellow to black by addition. Same as with SH_2 .	Reddish-brown insol	White insol	H_2HO_2 heavy yellow flk. insol in excess. In presence of ammonia soluble giving same flk as with $\text{NH}_4 \text{HO}$.	White heavy flk.
Bismuth Bi , 200.	S_3Bi_2 Black flk. insol in dilute acids, alkaline carbonates & CNK . Sol in boiling NO_2 Ho.	S_3Bi_2 Black flk. Same as with SH_2 .	White flk insol in excess.	White flk of basic carbonate insol in excess of CNK .	Bi HO_3 White flk insol in excess.	Bi HO_3 White flk insol in excess.
Copper Cu , 63.5	CuS Brown-black flk. insol in dilute acids & caustic alkaline. Sol in NO_2 Ho & CNK .	SCu Brown-black flk. Same as with SH_2 .	Green-black flk. Cu . Changes to brown-black hydrated oxide when boiled. Sol in NH_4HO to give a in CNK to clear fluid.	Same flk & reaction, as with $\text{NH}_4 \text{HO}$	Cu HO_2 White bulky flk. boiled in excess of M (part turns black).	White-blue flk, easily sol in excess to magnificent blue liquid.
Cadmium Cd .	CdS Orange-yellow. flk. Sol in HCl & strong NO_2 Ho & SO_2 Ho. Insol in alkaline sulphide & CNK .	CdS Light-yellow flk. Same as with SH_2 .	White flk insol in excess, sol in CNK . Warming activity appears.	White flk insol in excess unless see $\text{NH}_4 \text{HO}$ present	Gelatinous white flk insol in excess	White-white flk, readily sol in excess. Same as with OKH , CO Cl_2

Method of separating metals in Group I.

precipitate Mercurousum & Lead by adding excess of NH_4HO . filter

filtrate may contain Ag
add HCl of white pp Ag.

Residue may contain Hg or Pb
Dissolve in HCl .

Add OKH in excess. If black
pp remains Hg

Filtrate may contain Pb.

NH_4HO gives white pp insol in excess.

To separate metals in group II division I

To pp by SH_2 add strong NO_2HO & heat,

sol may contain Bi, Cu, Cd,

Residue may contain Hg
dissolve in aqua-regia.

If on adding CO NaO^2 reddish
brown pp Hg.

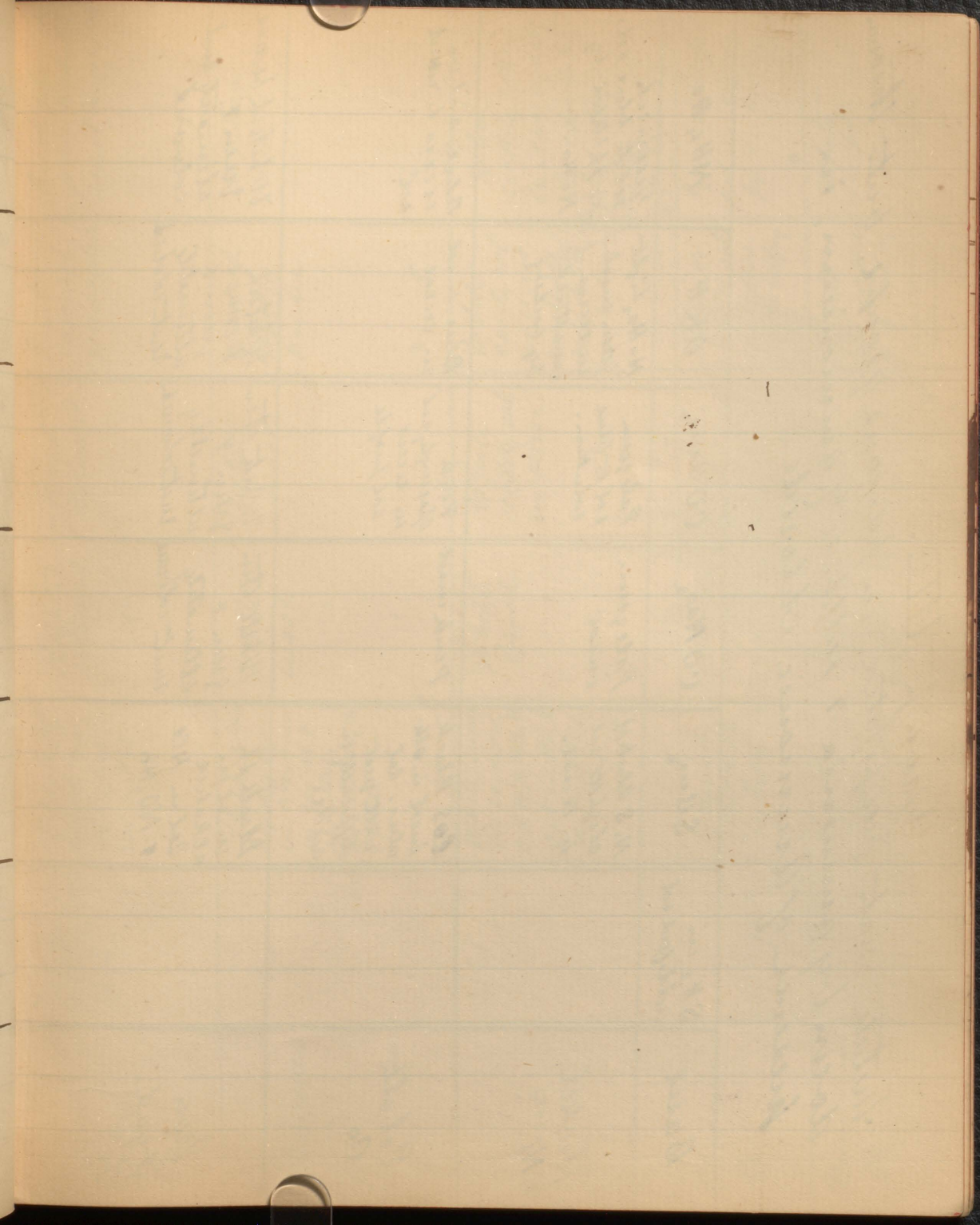
pp'ate sol by NH_4HO in excess
residue may
contain Bi.
Dissolve in ~~HCl~~
 HCl & add H_2S
if black pp Bi

filtrate may
contain Cu or Cd
pp'ate by SH_2 &
treat pp' with ENK
residue sol may
contain Cu.
may cont
Cd. Dissolve
in NO_2HO
& pp'ate by
 NH_4HO .
If white
pp'ate col in
excess to clear
fluid Cd
pp'ate with
 NH_4HO . If
light blue
pp'ate sol to
magnificent
blue fluid
Cu.

Group II.

Division II The sulphides sol in sulphide of Ammonium.

Base	S _H in acidified sol.	S Am ₂	CO NaO ₂	CO AmO ₂	OKH	NH ₄ HO
Zinc Zn	Brown-black Sol in yellow S _H with trace of acid in O.K.H. Na HO sol. (the by acids. Be compared in solution with ZnS)	Brown-black sol in excess same as with S _H	White insol	Bailey white insol in excess excess. S _H HO ₂	Bailey white sol in excess same as with CO AmO ₂	Bailey white sol in excess same as with CO AmO ₂
Sn tetrad	Light-yellow sol in O.K.H. alkaline sulphides, & boiling HCl & excess - regia. Also S Am ₂ from this, not by by acids in alcohol. Be compared with S _H in solution with with hydrochloric acid	Yellow sol same as with S _H	White insol	White insol S _N HO ₂	White sol same as with CO AmO ₂	White sparingly sol. same as with CO AmO ₂
Antimony Sb	Orange-red sp. sol in Na HO OKH + alkaline sulphite & strong HCl. Sparingly sol in NH ₄ HO, Insol in dilute acids.	Orange-red sol in excess same as with S _H	White sp sparingly soluble.	White, sparingly sol. S _b O ₃	White sol in excess same as with CO AmO ₂	White almost insol in excess same as with CO AmO ₂
Arsenic. As	Bright yellow sp. sol in alkaline, alkaline sulphides, carbonat. Na ₂ HO, Sublimat. one acid. readily insol in HCl.	Bright yellow sol in excess same as with S _H				

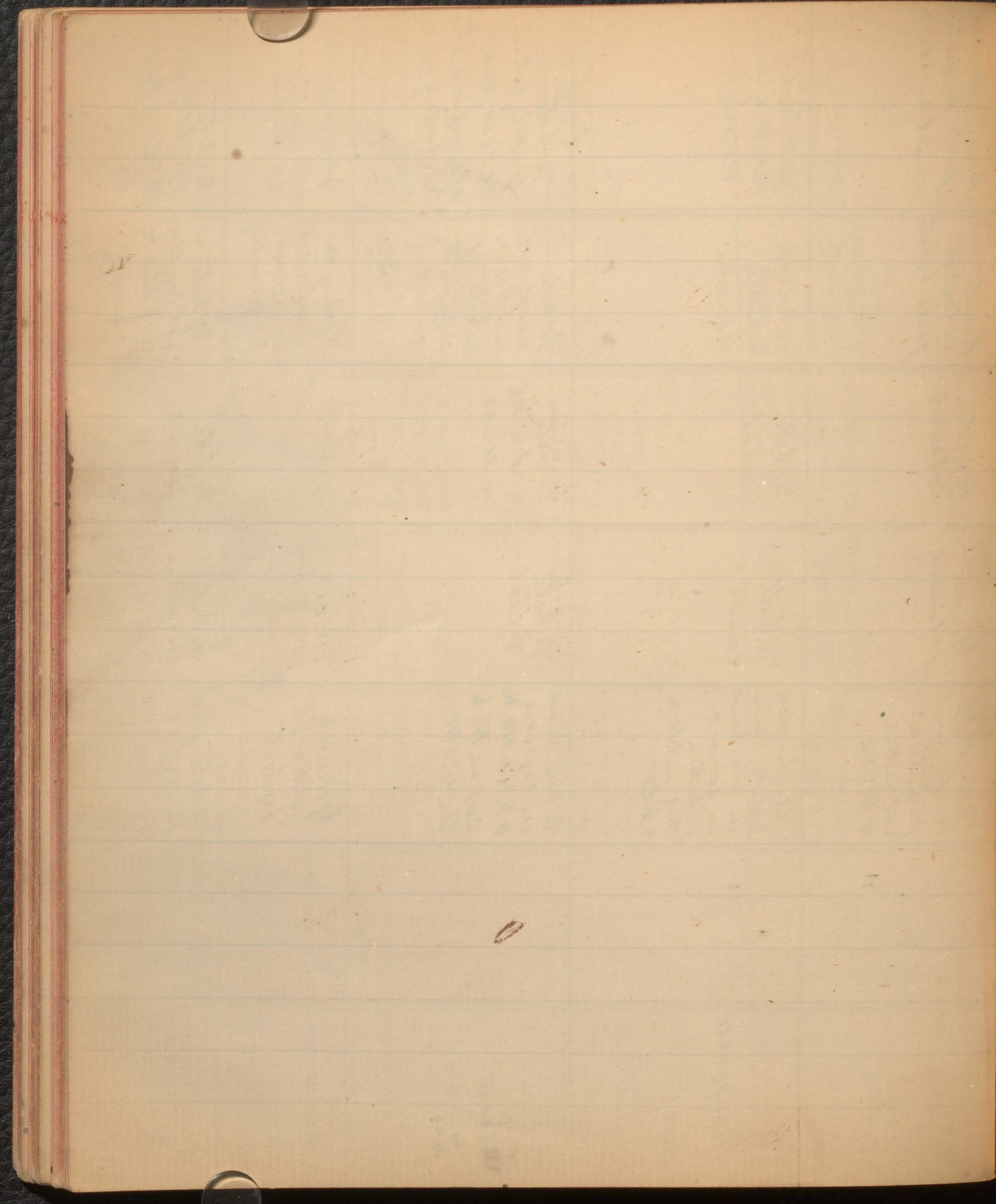


Group III.

Metals not precipitated in previous groups, but thrown down by ammonia & sulphide of Ammonium, in presence of Ammonic Chloride.

Base.	$S H_2$ in acidified sol	$S A m_2$	$C O N a_2 O_2$	$C O A m_2 O_2$	$O K H$	$N H_4 H_2 O$
Nickel Ni		Ni S Black H slightly sol in excess.	Pale green insol	Pale green sol to blue solution.	Ni $H_2 O_2$ Light green insol in excess unaltered by boiling	Greenish sol to blue sol. re. sp. tested by Na Ho.
Cobalt Co		Co S Black insol in alk- alies. sol with heat - difficult in acids.	Pink insol	Pink sparingly sol in excess sol purple.	Blue, insol in excess	Blue, sol in excess to reddish sol
Iron Fyad Fe		Black xH insol in alkalies. sol in HCl & $N O_2 H_2 O$	White, then green, & ultimately rust coloured	White, then green, & ultimately rust coloured	Whitish become green & ultimately rust coloured	Whitish become green & ultimately rust coloured.

Iron Hexad Fe ^{VI}	Turns milky from H ₂ S.	Black H ₂ insol in alkalis Sol in HCl & NO ₂ H ₂	Rust coloured	Rust coloured. ferriehydrate	Rust coloured ferriehydrate insol in excess
Manganese Mn		Black colour rapidly brown in air, insol in excess & alkalis. Sol in NO ₂ H ₂ & HCl.	White insol	Whitish rapidly brown.	Whitish rapidly brown.
Zinc Zn	White	White, insol in excess or OKH or NH ₄ HO Sol in NO ₂ H ₂ SO ₂ HO ₂ & HCl.	White insol	White easily sol in excess. nearly all at H ₂ SO ₄ on boiling.	White readily sol in HCl, nearly all except take on boiling.
Chromium Cr		Greenish yellow H ₂ hydrate	Green	Green or purple, sol in excess. H ₂ SO ₄ on boiling	Green or purple sol in excess H ₂ SO ₄ on boiling
Aluminium Al		White insol in excess sol in OKH & NH ₄ HO	White insol	White sol in excess at H ₂ SO ₄ by boiling	White slightly sol boiling H ₂ SO ₄ at boiling.



Group IV.

Metals not precipitated in previous groups, but thrown down by Ammonic Carbonate, in presence of Ammonic Chloride, (as Carbonates)

Base	S^{H_2} in acidic sol	S^{Am_2}	CO NaO_2	CO AmO_2	OKH	NH_4Ho .
Barium Ba	0	0	White insol in excess sol in NO_2^{Ho} & HCl	White insol in excess sol in NO_2^{Ho} & HCl.	0	0
Strontium Sr	0	0	White insol.	White insol	0	0
Calcium Ca	0	0	White insol in excess	White insol	0	0

Group V.
Metals not precipitated in previous groups.

Base	S _H ₂	SAm ₂	CONaO ₂	COAm ₂	OK#	NH ₄ HO
Magnesium	0	0	White insol on boiling	0	White insol	White insol
Bases.	PECl ₄	Fartaric acid.				
Potassium K	Yellow crust sp.	Heavy eight sp. falls slowly on stirring.				
Sodium Na	0	0				
Ammonium	Yellow crust sp.	Heavy acid sp. falls slowly on stirring.				

Preliminary examination

Ex I. Heated a small quantity in a tube.

It changed colour without decomposition.
yellowish brown when hot, light yellow
when cold.

Ex II Heated a little of substance on charcoal
before blowpipe. Gave metallic globules, (brittle)
& incrustation orange, or yellowish-brown
hot, yellow cold.

Deduction from experiments. Bi.

~~Group I.~~

General table.

Added HCl to original & heated gently. No ppt

Diluted with water & passed SH_2 & heated gently.

A ppt black
crisol in NaHO
May be CuS
 As_2S_3 , PbS , Bi_2S_3

Examined
by table II.

Group 2.

Washed ppt. Boiled with NaHO & filtered.

Residue washed well. Boiled in concent $\text{NO}_2 \text{HO}$, dilute with OH_2 , added dilute $\text{SO}_2 \text{HO}_2$. No ppt. added equal bulk of alcohol filtered.

Boiled of alcohol added excess of amHO filtered.

Dissolved in HCl vap to dryness will turn on addition of OH_2 by formation of BiOCl
Pres of Bi

Analysis 3. Preliminary examination.

I. Experiment	Observation	Inference.
Heated a small portion in a dry tube.	II Substances Changes without decomp 2 nd <u>Substance fuses</u>	A salt of alkalis or one of alkaline earths.
Heated a little on charcoal before blowpipe	3 substance fused readily & formed bead	A salt of alkalis or alkaline earths.
Heated in the inner blowpipe flame.	Coloured outer flame crimson	Sr.

General Table

Added HCl & heated gently. No ppt.

Passed SH_2 & heated gently. No ppt.

Added Am Cl, Am H_2O , & SAmg No ppt.

Added Am H_2O & COAmo_2 ppt

May contain

Co Bao"

Co SrO "

Co Cao"

Dissolved ppt in last possible amount of HCl
Hydrofluosilicic acid gave no ppt. Absence of Ba
 SO_2 Cao" gave white ppt. Sr.

Analysis 4.

Preliminary examination.

I heated a small
quantity of subst
in a tube

mitted & gave off OH_2

Salt of the alkalies
& alkaline earths.

II heated a little
of substance on
charcoal before
blowpipe.

An infusible luminous
mass left.
Alkaline to litmus

Ba Sr Ca Mg.

Confirmed by
heating again with
a few drops of HNO_3 & CO_2

A flesh coloured
mass left

MgO

In the Wet way.

Added HCl & heated gently. no ppt.

Diluted with OH_2 & passed SH_2 . no ppt.

Added AmCl , AmHo & SAm_2 ppt came down, but sol in excess of AmCl

a	b	Added AmHo & CO Am_2 to sol no ppt
---	---	---

ignite evap. to dryness & ignite	
Dissolves in OH_2 , HCl but with AmCl , AmHo & POHoNa , ppt comes down	
Pres of Mg !	

Analysis 5th

Preliminary examination.

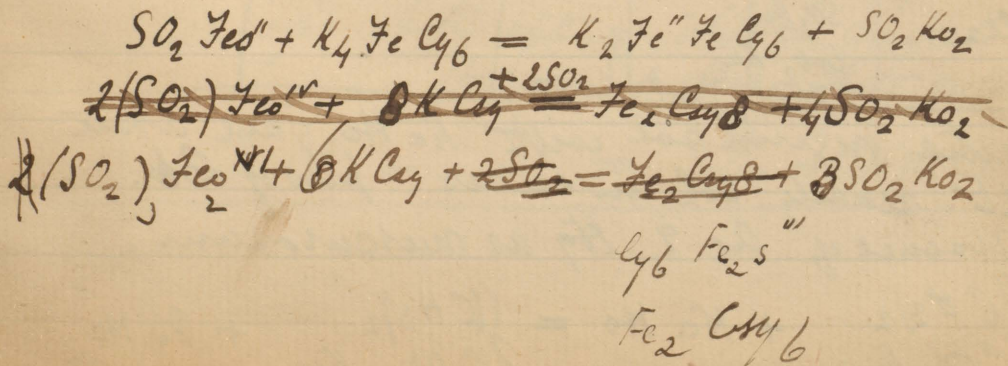
Experiment	Observation	Inference
I Heated a small portion of the substance in a tube.	Evap. of acid fumes & changed to red colour.	Some salt with volatile acid, or acid salt.
II Heated on charcoal before blowpipe.	Left red residue	
III Confirmed by heating the substance in a borax bead.	gave brown-green bead when hot, lighter coloured when cold, in both flames	Fe or Ni

In the Wet way.

Added HCl & heated gently. No ppt.

Abs of Ag Pb Hg ⁺	Diluted & passed S _H 2 & warmed. No ppt.	Added AmCl, Am ^{NO} , SAm ² gave ^{crack} ppt.	
Cu Bi Cd Sn ⁺⁺ Sn ^{IV} Sb As Au Pt	may be CoS } NiS } ^{black ppt} FeS }		
	Zn Mg Cr Al		

Tested by OKH. gave greenish ppt, becoming rusty Fe
 Confirmed by Ferricyanide of Potash. ^{turns} ~~Prussian~~ blue ppt Fe
 Distinguish between Fe⁺⁺ & Fe⁺⁺⁺ mixed with dark blue
 Potassic Ferricyanide gives a light blue ppt Fe⁺⁺ & Fe⁺⁺⁺
 Potassic Sulphocyanide gives a blood red ppt Fe⁺⁺⁺
 Solution contains a mixture of Ferrous & Ferric
 salts.



Analysis 6.

Preliminary examination.

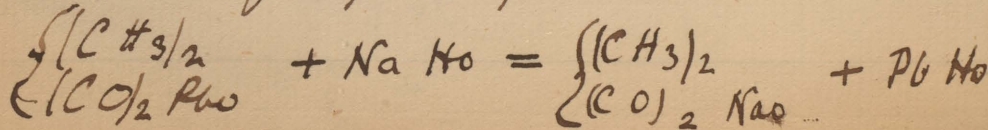
Experiment	Observation	Inference
I Heated a small portion of substance in a tube.	Subst first fused & then decomposed giving an odour of acetone, & finally became carbonised. residue does not effervesce with acids.	Some acetate not of the alkalis or alkaline earths.
II heated substance on charcoal before blow pipe	It was reduced to the metallic state with a brown-yellow incrustation when hot lemon yellow when cold Metal malleable	Pb.

In the wet way.

Added HCl, gave a heavy white ppt.

May be pres AgCl white PbCl ₂ " Hg ₂ Cl ₂ "	Gr 2	Gr 3 A	Gr 3 B	Gr 4	Gr 5
	SO ₂ H ₂ CrO ₂ K ₂ PbCl ₂	sol. in H ₂ O			

Tested original sol with Na HO, gave white ppt. readily sol in excess. pres of Be.
 Absence of Ag & Hg as mercurousum.



Analysis of it in the dry way
Preliminary.

Experiment	Observation	Inference
I Heated substance in a tube.	remained unchanged but was yellow when hot white when cold	ZnO
II Heated on charcoal before blowpipe	remained unchanged but was yellow when hot white when cold	
Confirmed by heating after adding a few drops of SnO_2 CoO	A green mass was left	ZnO

~~Added HCl & warmed. No ppt~~

As the substance was dissolved in HCl
It cannot belong to Group I.

Added SH_2 & warmed No ppt.

Added NH_4Cl , NH_4Ac & SAm_2 . gave copious white ppt. which must be Zn, as there is no other white sulphate.



Analysis 9.

Preliminary examination

Experiment	Observation	Inference
I Heated in a tube	Changed colour & gave off fumes of NH_3 alkaline to test paper	An ammonium salt or cyanide in presence of water, or from the decomposition of organic substances
II Heated w/ht on charcoal confirmed by heating in borax bead.	left coloured residue gave green bead in both flames	Cr_2O_3

In the wet way.

Added HCl & warmed. no ppt.

Abs of	Added H_2S & heated gently. no ppt.	Added Am Cl , Am NO_3 & $5Am_2$. gave ppt																																																						
$AgCl$ white	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%;">Abs of</td> <td style="width: 15%;">Added</td> <td style="width: 15%;">in $NaOH$</td> <td style="width: 15%;">or $3Am_2$</td> </tr> <tr> <td>$PbCl_2$ "</td> <td>PbS black</td> <td></td> <td></td> </tr> <tr> <td>Hg_2Cl_2 "</td> <td>HgS "</td> <td></td> <td></td> </tr> <tr> <td></td> <td>CuS "</td> <td></td> <td></td> </tr> <tr> <td></td> <td>As_2S_3 "</td> <td></td> <td></td> </tr> <tr> <td></td> <td>CdS yellow</td> <td></td> <td></td> </tr> <tr> <td></td> <td>SnS brown</td> <td></td> <td></td> </tr> <tr> <td></td> <td>SnS_2 yellow</td> <td></td> <td></td> </tr> <tr> <td></td> <td>Sb_2S_3 orange</td> <td></td> <td></td> </tr> <tr> <td></td> <td>Sb_2S_5 "</td> <td></td> <td></td> </tr> <tr> <td></td> <td>As_2S_5 yellow</td> <td></td> <td></td> </tr> <tr> <td></td> <td>As_2S_3 black</td> <td></td> <td></td> </tr> <tr> <td></td> <td>PtS_2 "</td> <td></td> <td></td> </tr> </table>	Abs of	Added	in $NaOH$	or $3Am_2$	$PbCl_2$ "	PbS black			Hg_2Cl_2 "	HgS "				CuS "				As_2S_3 "				CdS yellow				SnS brown				SnS_2 yellow				Sb_2S_3 orange				Sb_2S_5 "				As_2S_5 yellow				As_2S_3 black				PtS_2 "			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;"> may be CoS black NiS " ZnS white MnS flesh colour FeS black Cr_2O_6 bluish green Al_2O_3 yellowish white gelat </td> <td style="width: 50%;"></td> </tr> </table>	may be CoS black NiS " ZnS white MnS flesh colour FeS black Cr_2O_6 bluish green Al_2O_3 yellowish white gelat	
Abs of		Added	in $NaOH$	or $3Am_2$																																																				
$PbCl_2$ "		PbS black																																																						
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Ppt being bluish green must be Cr_2O_6
 Confirmed by $ONaCl$ & heating liquid turned yellow from formation of Chromic acid. add $\frac{C_2O_4}{CO_2}$ / PbO

$$2 \begin{matrix} SO_2 \\ SO_2 \\ SO_2 \end{matrix} Cr_2O_3 + 3ONaCl + 5OH_2 = Cr_2O_6 + 6NaCl + 6HCl$$

Analysis 10

Experiment	Observation	Inference
heated in a tube	gave off water of crystallization.	Salts containing OH_2 of crystallization
Heated on charcoal	fused & residue alkaline to test paper & white.	Ba. Sr. Ca. Mg.
heated in inner flame	gave yellow-green colour	Ba

Added HCl & heated gently no ppt

Abs of	Added H_2S & gently heated no ppt.	Added AmCl, Am NO_3 , & Am S no ppt	Added Am NO_3 & CO Am NO_3 ppt
AgCl	Abs of	Abs of	may be
PbCl_2	PbS	COS	CO Ba O white
Hg_2Cl_2	CuS	NiS	CO Sr O "
	Hg_2S	ZnS	CO Ca O "
	Bi_2S_3	MnS	
	CdS	FeS	
	SnS	Cr_2O_3	
	SnS_2	Al_2O_3	
	Sb_2S_3		
	Sb_2S_5		
	As_2S_3		
	As_2S_5		
	PtS_2		

Tested with SiH_2F_6 gave when alcohol added a white ppt. Ba

Tested with CrO_2K_2 gave canary yellow ppt Ba

Analysis II.

Experiment	Observation	Inference
heated in tube	Sublimed with white fumes without melting	Am
On charcoal	Sublimed without white fumes without melting.	

In the wet way.

Added HCl. no ppt.

Abs of	Added SH ₂ no ppt.	Added Am Cl, Am H ₂ , & Am ₂ S. no ppt.	Added Am H ₂ & CO Am ₂ no ppt.	Sol may contain
AgCl	Abs of PbS HgS CuS Bi ₂ S ₃ CdS SnS SnS ₂ Sb ₂ S ₃ Sb ₂ S ₅ As ₂ S ₃ As ₂ S ₅ Pt ₂ S ₂	Abs of CO ₂ NiS ZnS MnS FeS Cr ₂ H ₂ O Al ₂ H ₂ O	Abs of CO BaO" CO SrO" CO CaO"	K ₂ O Na ₂ O Mg ₂ O
B ₂ Cl ₂				
Hg ₂ Cl ₂				

- 2 { Added O Na H to some of orig sol in test tube, heated gently, odour of NH₃ given off Am
- 1 { Added PtCl₄ to orig sol gave a yellow crust ppt over

(Note.)

The ppt of K & Am by $PtCl_4$ may be distinguished, thus. The ammonium ppt volatilizes & leaves metallic Pt. The potassium ppt decomposes into metallic Pt - KCl & free Cl. When KCl dissolved out gives ppt of $AgCl$ with NO_2 & Ag_2O_2 & proves presence of K.

Analysis 12.

Experiment	Observation	Inference
I heated in tube	Changed to black colour.	
II Heated on charcoal	Changed to black colour.	
Confirmed by heating in borax bead	gave brown bead in both flames	Ni

In the wet way.

Tested with SH_2 as ppt.

Abs of	Added	Result
Pb	Sb	May be -
Hg	As	Added NaOH NaOH $ONaOH$ gave
Cu	Am	light green ppt insol in excess NH_3
Bi	Fe	Added Ferrocyanide of potassium, gave
Ca		a brown - yellow ppt. Ni
Sn		

Thursday Nov. 24. 1869

white cryst. subst
Analysis 13.

Preliminary.

Experiment	Observation	Inference
Heated in tube	boiled & gave off water of crystallization	from the decomposition of some substance containing Ammonium & a sulphite or sulphate.
Heated on charcoal	then crystals obtained & 2 fine ellip. gask off above of SO_2 left white residue	Ba Ca Sr Mg Al Zn & SiO_2
Confirmed by heating after melting with H_2O_2 Cool	gave a fine blue mass	Al_2O_3 earthy phosphates silica or some silicate.

In the wet way.

Added HCl to sol & gently heated no ppt

Abs of	Added	S^{H_2} no ppt.
$AgCl$	Abs of	Added Am Cl, Am NO_3 , & Am_2 gave
Hg_2Cl_2	PbS black	gelatinous ppt. May be
$PbCl_2$	HgS "	$Cr_2H_2O_7$ & $Al_2H_2O_6$.
	CuS "	AlK gave white ppt readily sol
	Bi_2S_3 "	in excess. $Al_2H_2O_6$.
	CdS yellow	NH_4H_2O gave a white ppt $Al_2H_2O_6$
	S_2S	
	S_2S_2	
	S_6S_3	
	S_6S_5	
	As_2S_3	
	As_2S_5	
	P_2S_5	

(white cryst subst)

Analysis No.

Preliminary examination.

Experiment	Observation	Inference
I Heated in tube	Substance did not change	
II Heated on charcoal	left a white residue alkaline (felly) to test paper.	Ba S ₂ Ca or Mg

In the wet way.

Added SH₂ & obtained no ppt.

Abs of	Added Am Cl, Am to, & Sam ₂ gave no ppt
Hg S black	Abs of
Pb S "	Co S black
Cu S "	Ni S "
Bi ₂ S ₃ "	Zn S white
Cd S yellow	Mn S flesh
	Fe S black
	Cr ₂ Ho ₆ bluish green
	Al ₂ Ho ₆ white plat
	Added Am to & Co Am ₂ gave white ppt.
	May contain
	CO Bao ^o
	CO Cao ^o
	CO Si ^o
	gave no ppt with
	SO ₂ Cao ^o - <u>Ca</u> .
	gave no ppt with
	CrO ₂ Ko ₂ - <u>Ca</u> .
	gave no ppt with
	Si H ₂ F ₆ - <u>Ca</u> .

- Sn S
- Sn S₂
- Sb₂S₃
- Sb₂S₅
- As₂S₃
- As₂S₅
- PE S₂

Analysis 15-

A white substance, in small crystals.

Experiment	Observation	Inference
Heated in tube.	partially sublimed (with difficulty)	Cd compounds.
Heated on Charcoal	fused & sank into the charcoal, gave white fumes then	
Heat with Co Nas. on charcoal.	volatilizes & gives yellowish brown incrust. readily volatil.	

Substance in the wet way

Added HCl & heated gently. no ppt

As ₂ S ₃	Added S H ₂ gave a yellow ppt	
As ₂ S ₄	May be	Added Na H ₂ O ppt - insoluble must be Cd S.
Pb Cl ₂		
Hg ₂ Cl ₂		
	Cd S	
	Sn S ₂	
	Sb ₂ S ₃	
	As ₂ S ₃	

Analysis 16

Preliminary examination

Experiment	Observation	Inference
I Heated in tube	volatilized after fusing & sublimed.	$HgCl_2$
II Heated on Charcoal	volatilized	
heated in tube with CO & Na_2O gave a red sublimate & globules of metallic Mercury	gave acid sublimate & globules of metallic Mercury	Hg .

In the wet way

Added HCl & heated gently w/ ppt

Abs of $AgCl$ Hg_2Cl_2 $PbCl_2$	Added SH_2 gave a ppt. first white, then orange, finally black. Hg
	Black ppt may be CuS , PbS , Bi_2S_3 , HgS
	Added $NaHCO_3$ gave heavy yellow ppt Hg
	Added CO Amos gave a brown-red ppt Hg

Hg as Mercuricum.

(Greenish Cryst. Sub) Analysis 16

Experiment	Observation	Inference
Heated in tube	gave up water of crystallization. Then gave off ammonia (alkaline reaction) & finally SO_2 suffocating smell & acid reaction	Some salt containing NH_3 & S. Probably an ammonia-sulphate
Heated on charcoal test	Left a coloured residue black outside red within	
Confirmed by borax bead.	Gave a yellowish bead when hot nearly colourless when cool or Fe . Orange reddish when hot lighter when cold refined	Fe Fe.

In the wet way.

Added HCl no ppt.

Abs of $AgCl$	Added S^{H_2}	gave no ppt.
$PbCl_2$	Abs of	Added $AmCl$, AmH_2 , & S^{H_2} gave a black ppt. May be CoS , NiS , FeS .
Hg_2Cl_2	Pb	
	Hg	
	Cu	
	Ni	Added Potassic ferrocyanide to orig sol gave deep blue ppt Fe^{II}
	Ca	
	Zn	Added Potassic sulphocyanide to orig sol, gave no colorative absence of Fe^{VI}
	Mg	
	As	
	Am	
	H_2	

Ferrous salt of Fe.

(Black Uranyl) Analysis 17

Experiment	Observation	Inference
I Heated in tube	remained unaltered	
II Heated on charcoal	left a black residue	
confirmed by heating in borax bead	gave blue bead in both flames	CO

In Wet Way.

Added $S H_2$ gave no ppt

abs of
 PbS
 HgS
 CuS
 Bi_2S_3
 CdS
 SnS
 SnS_2
 ~~Sb_2S_3~~
 ~~Sb_2S_5~~
 ~~As_2S_3~~
 ~~As_2S_5~~
 ~~SnS_2~~
 ~~PtS_2~~

Added $AmCl$, $AmCl_2$, & $S Am_2$
gave black ppt,

Must be

COS
 NiS
 FeS

Added $CO Na_2O_2$ gave
pink ppt = Co

Added Na_2O_2 gave blue
ppt insol in excess = Co

Added $K_4 Fe C_6$ gave green
ppt = Co

Analysis 18

Black pulverulent substance

Experiment	Observation	Inference
I Heated in tube	no change	
II Heated on charcoal confirmed by borax bead	<p>no change</p> <p>gave metallic globules of Cu when heated with Cu_2O & Cu_2S</p> <p>gave green when hot blue when cold in re flame & red in ox flame</p>	<p>Cu</p> <p>Cu</p>

In Wet Way.

Added $S H_2$ gave a black ppt.

Must be

- PbS
- HgS
- CuS
- Bi_2S_3

Tested with $Am H_2O$ gave a whitish ppt, & then a magnificent blue liquid. Cu

White Cryst

Analysis 19

Experiment	Observation	Inference
Heated in tube	fused & gave off water without decomp.	Salts of alkalies or alkaline earths
Heated on charcoal	dehydrated	Nitrate chlorides &c
Coloured outer flame blue	coloured outer flame lilac	K.

In the ~~Wet~~ way.

Tested with HCl no ppt

Avg	Added SH_2 no ppt.		
As ₂ Se ₃	Abs of } PbS HgS CuS Bi ₂ S ₃ CdS SnS S ₂ S ₂ S ₂ S ₃ S ₂ S ₄ As ₂ S ₃ Ar ₂ S ₃ PtS ₂	Added AmCl, AmK ₂ & SAm_2 no ppt	
H ₂ Se ₂		Abs of } COS NiS MnS ZnS FeS Cr ₂ H ₆ Al ₂ H ₆	Added AmH ₂ & CO Am ₂ no ppt
PbSe ₂			Avg of } CO BaO CO SrO CO CaO

Analysis 20
In the dry way.

Heated on charcoal with CO Nav & CNK	reduced to metallic state with slight yellowish encrustation metal malleable	Sn
---	---	----

Dissolved globule in HCl by the
aid of galvanic action, between it & a piece of
platinum foil. Sol gave white ppt
changing to grey on boiling with mercurous
salt Sn

Sol gave purple ppt with AuCl₃ Sn
Sol gave metallic tin when Zn introduced
into the solution; in a spongy state Sn
Sol gave a brown ppt with SH₂ Sn''.

Analysis 21

Experiment	Observation	Inference
Heated in tube	boiled, then volatilized in small shining crystals, & finally combined & gave a brittle metallic mirror on the tube from the action of the Carbon.	As combined with some organic substance

Dissolved in HCl & added S^{H}_2 , gave yellow ppt sol in $NaHO$ must be SnS_2 , Sb_2S_3 , or As_2S_3 .

Added to a sol containing excess of $NaHO$ a drop of SO_2 "Cuo", gave blue liquid, which when boiled gave a reddish ppt of Cuprous Oxide, Arsenious acid.

Analysis 22.

Experiment	Observation	Inference
Heated in tube	Melted & gave off acid fumes, smelling of garlic	Sb or As
Heated on charcoal with CO gas & CNK	gave metallic globules brittle, & white incrustation, globules gave off white fumes when taken from the flame	Sb

Dissolved in HCl by the aid of heat. Substance gave off $S\text{H}_2$ - a sulphide. Boiled till free from $S\text{H}_2$ & added $S\text{H}_2$ to diluted sol gave orange ppt, insol in NaOH .

Must be Sb, As, or Sn, Placed part of sol in a test tube, & added Zn & HCl held porcelain in flame of H & it gave a mirror. Must be Sb or As.

Mirror insol in O Na Cl — Sb.

Nov 30 1869

Reactions of the Acids.

Hydrosulphuric acid, SH_2

Dry reaction.

Some sulphides heated give a sublimate of S, (or smell of SO_2)

Wet reactions.

$\text{SH}_2 + 2\text{NO}_2 \text{ Ag} = \text{Ag}_2\text{S} + 2\text{NO}_2 \text{ Ho}$
brown ppt insol in dilute acids.

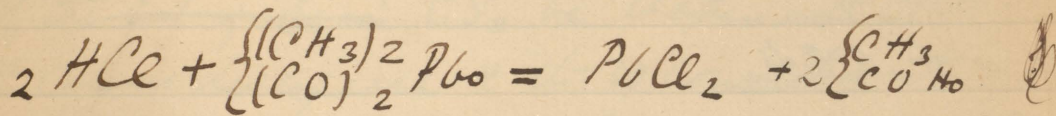
$\text{SH}_2 + \begin{matrix} (\text{CH}_3)_2 \\ (\text{CO})_2 \end{matrix} \text{Pbo} = \text{PbS} + \begin{matrix} \text{CH}_3 \\ 2\text{CO Ho} \end{matrix}$
black ppt insol in dilute acids.

Many sulphides when heated with dilute HCl give off ~~H₂~~ SH_2 which may be recognised by its action on lead paper.

Some sulphides (as Iron & Copper pyrites) $[(\text{FeS}_2) \text{ or } (\text{FeS}_2, \text{CuS})]$ do not give it off readily till a piece of Zn is introduced, but then give it off mixed with H, in abundance

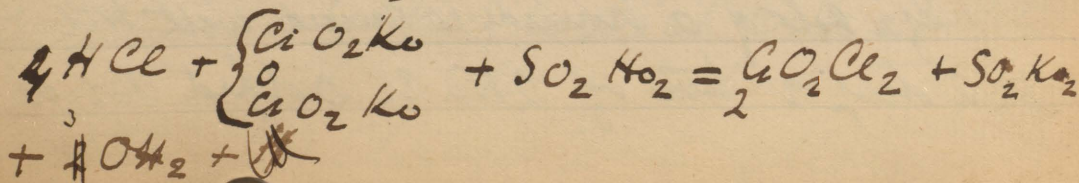
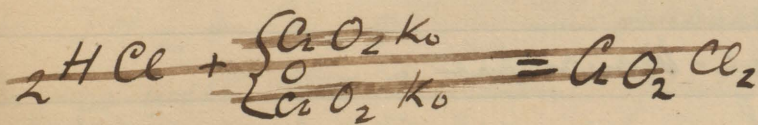
Hydrochloric acid.

$HCl + NO_2 AgO = AgCl + NO_2 Ho$
 white curdy ppt insol in dilute acids
 but sol easily in $AmHo$ & CNK .

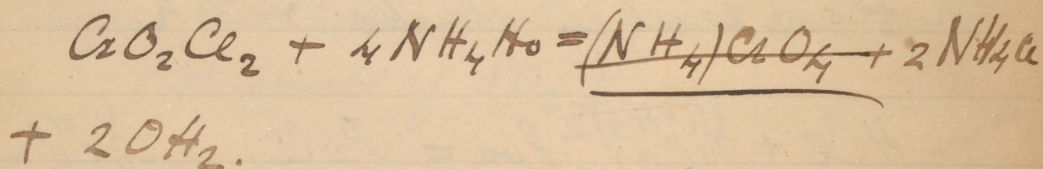


$2 KCl + SO_2 Ho_2 = 2 HCl + SO_2 Ko_2$
 recognised by its fumes with air, &
 smell

$2 KCl + SO_2 Ho_2 + MnO_2 = 2 Cl + SO_2 Ko_2$
 $+ 2 OH_2 + MnO$ $SO_2 MnO$
 Cl recognised by its colour & bleaching action.

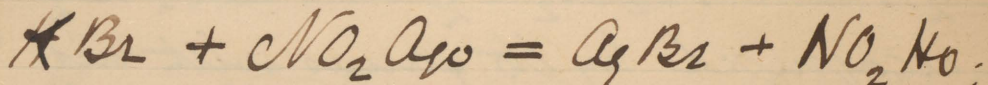


a brownish red gas (chlorochromic acid) which may be condensed in a receiver & gives with excess of AmHo a yellow liquid; thus $\text{CrO}_2 \text{AmO}_2$.

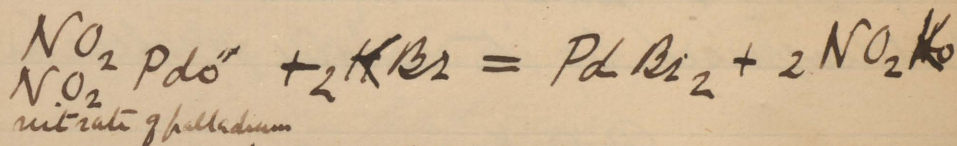


Insol. Chlorides

Hydrobromic Acid, HBr



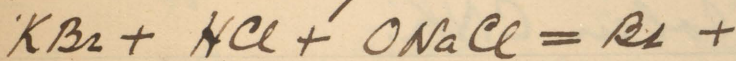
Yellowish white ppt, turns grey by light.
Insol in dilute $\text{NO}_2 \text{Ho}$, but ^{difficultly} sol in AmHo & CNK.



reddish-brown ppt.

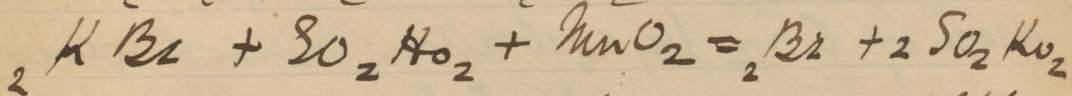
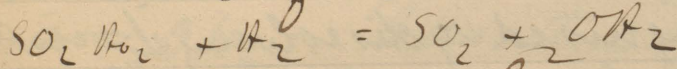
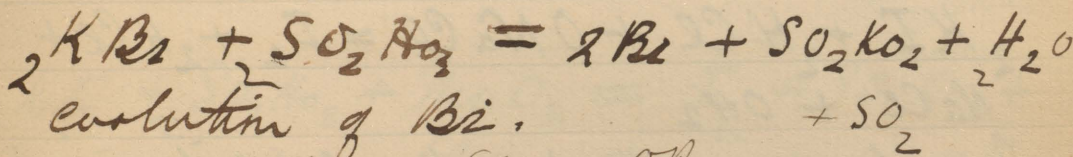
If a sol of a bromide is mixed with HCl & a drop or two of ONaCl added Br is

liberated & tinges the liquid yellow. By adding a drop of CS_2 the colour may be concentrated, by its action in dissolving the Br_2 , & Br thus detected in very weak soln.



If the sol of Br_2 in CS_2 be shaken with OH^- the colour disappears & it is converted into Bromide & Bromate of K.

If a sol of a bromide is mixed with HCl & NO_3^- no Br_2 is liberated. Distinction between Br & I.



+ OH^- + MnO . The presence of chlorides interfere with this reaction. Gently heat the mixture in a beaker, covered with a watch glass to which a slip of iodised starch paper is stuck. Br_2 changes it to yellow.

Hydroiodic Acid, HI.

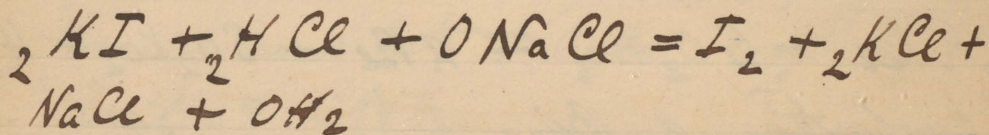


yellow-white ppt blackens with light,

Insol in dilute NO_2Ho & hardly sol in NH_4Ho . Sol in CNK.

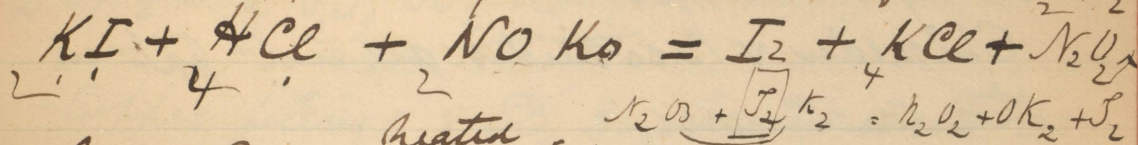
Chloride, & nitrate of Palladium produce a dark brown ppt of PI_2 .

If a sol of an Iodide is mixed with HCl & a drop of $ONaCl$ added, Iodine is liberated.

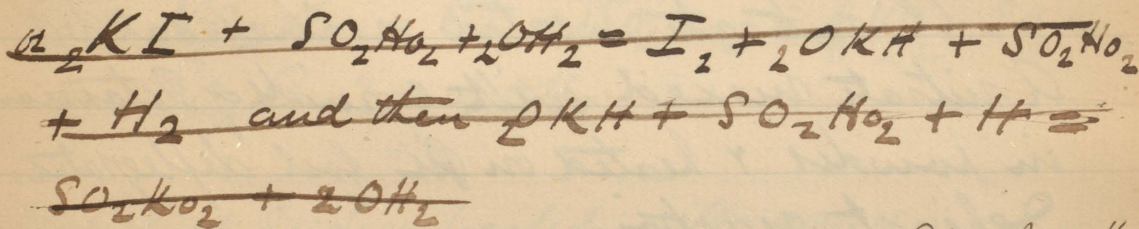
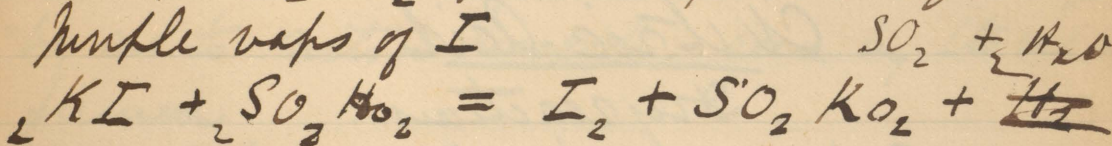


May be recognised by dissolving it in a drop of CS_2 by agitation, when it gives it a beautiful purple colour, or by adding starch solution, which gives a fine blue colour.

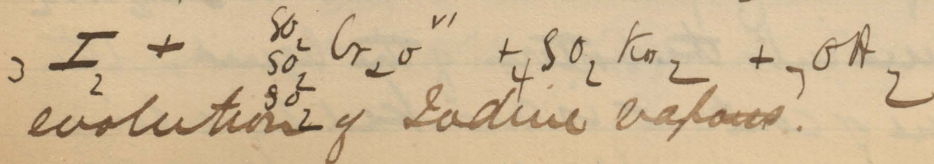
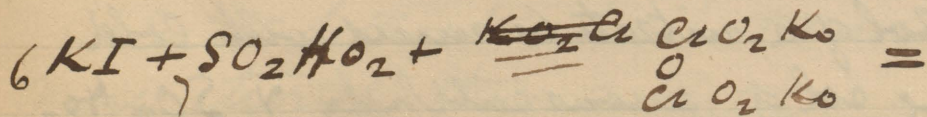
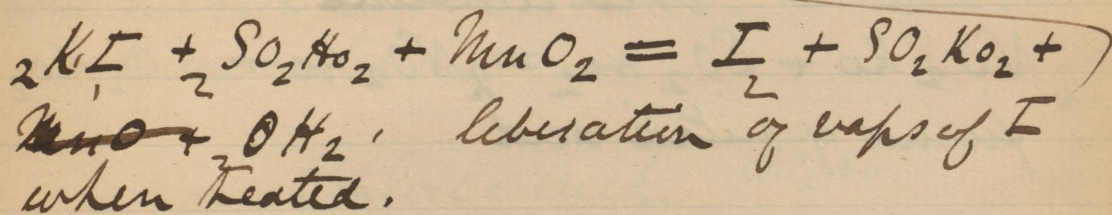
If a sol of an Iodide be mixed with HCl
 & a drop or two of Potassic nitrite added I
 is liberated, & may be detected as before. $+ \frac{1}{2} O H_2$

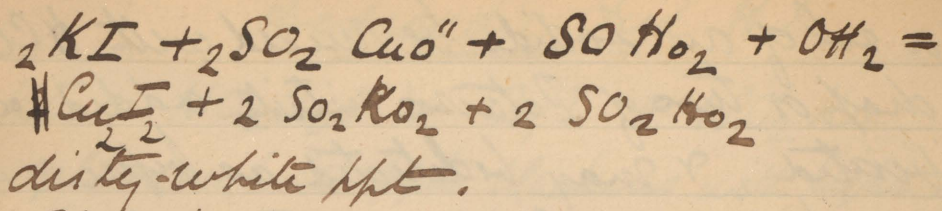


Strong $SO_2 H_2O$ with dry Iodides gives
 purple vaps of I



SO_2 "Mao"





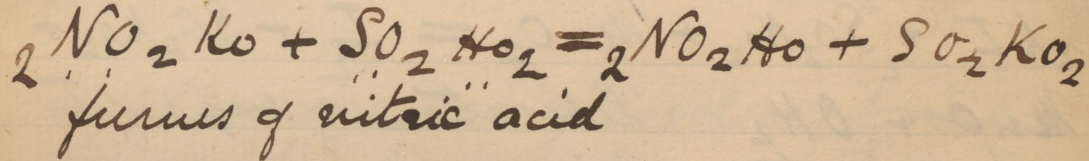
Chlorides & Bromides are not ppt in this manner.

Nitric Acid

Dry reactions.

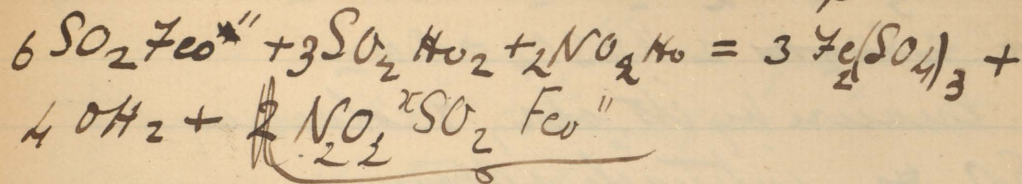
A nitrate heated on Charcoal decomposes
 A nitrate mixed with cyanide of Potassium
 in powder & heated on Pt foil decomposes.
 Delicate reaction.

Wet reactions

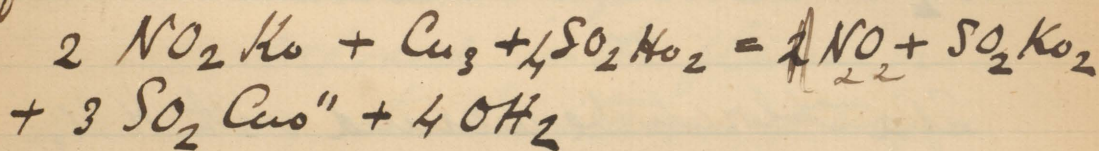


If sol of a nitrate be mixed with cold strong sol of fuming sulphate & $SO_2 \text{ Ho}_2$ poured into the bottom of the liquid, the plane of contact is marked by a line of brown or purple, caused by the nitric

oxide dissolved in the Ferrous Sulphate.



Copper filings + $\text{SO}_2 \text{Ho}_2$ heated with a nitrate liberate nitric oxide, which changes by air to nitric peroxide. seen by its red fumes.

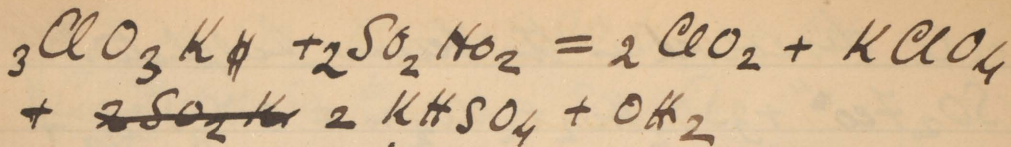


Sol of Indigo boiled with HCl & a sol of a nitrate is decolorised. Delicate but not characteristic.

Chloric Acid $\text{ClO}_2 \text{Ho}$

Chlorates decompose when heated on charcoal more strongly than nitrates.

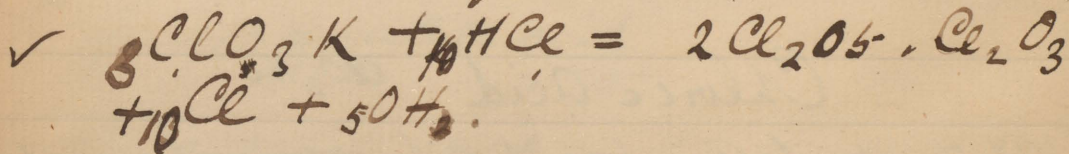
Mixed with CNK & heated on Pt-foil they detonate violently.



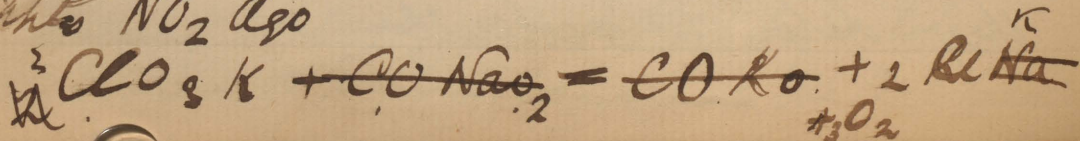
known by its odor, & colouring the $\text{SO}_2\text{H}_2\text{O}$ intensely yellow

If a sol of a Chlorate be mixed with $\text{SO}_2\text{H}_2\text{O}$ tinted with sol of indigo & SO_2 added the blue colour disappears

If a chlorate be warmed with HCl , water, chlorine, & chlorochloric anhydride are formed. Tube becomes filled with greenish gas having disagreeable odor & Indigo sol is bleached.



If a chlorate is mixed with $\text{CO Na}_2\text{O}$ & heated O is given off & a chloride remains, which
 into NO_2 gas



Boracic acid

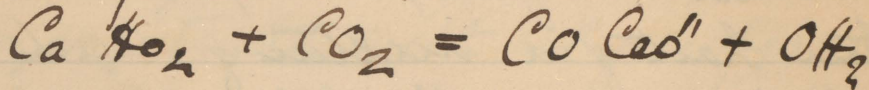
Lumps burn in flame green. Borates fused with CO or Na_2O_2 give characteristic lines in spectroscope.

If a substance containing boracic acid be reduced to fine powder, & mixed with three parts of a mixture of acid sulphate of potassium & calcium fluoride, & the whole exposed in the flame, on a Pt wire, the flame is tinged green for an instant.

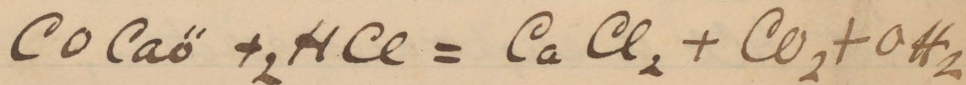
If a solid alkaline borate be mixed with HCl to slight acid reaction, a slip of turmeric paper introduced, & then dried at 100° . It assumes a peculiar red tint, which when moistened by an alkali turns blackish blue. The colour is immediately restored by HCl .

Carbonic Acid

Limewater produces with CO_2 a white ppt. sol with effervescence in acids, and not reprecipitated by ~~boiling~~ CaO when the CO_2 has been expelled by boiling.

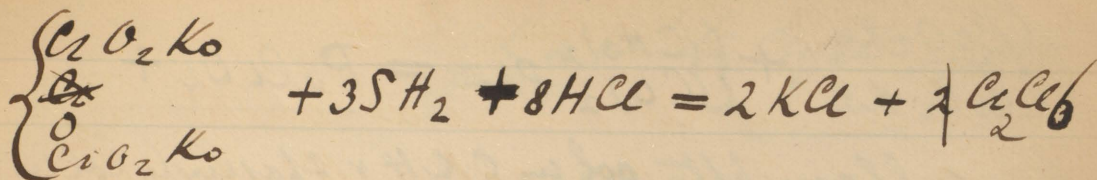


HCl added to a carbonate produces effervescence, by evolution of CO_2 which may be recognized by want of smell, or by holding a rod dipped in limewater in the tube.

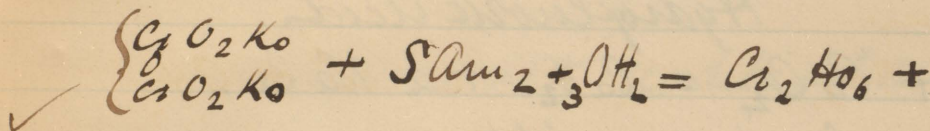


Chromic acid

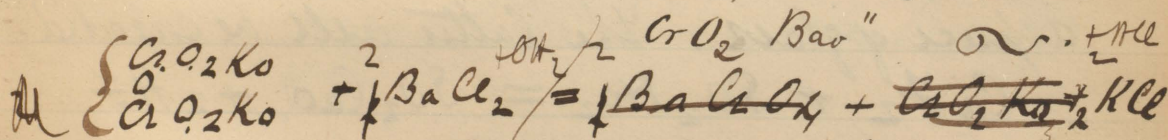
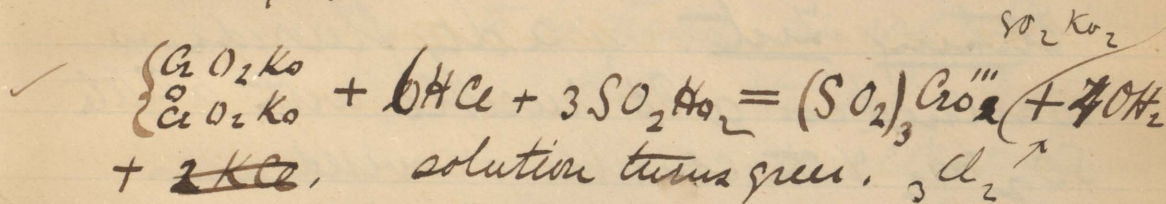
Compounds of chromic acid give a emerald green bead in both flames, (brightest in the outer).



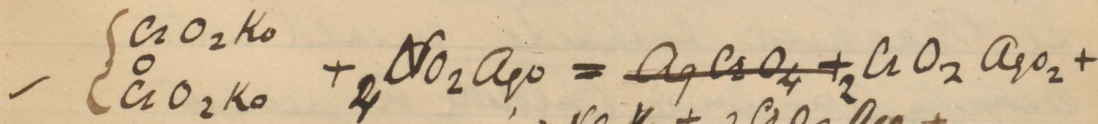
+ 70H₂ + 3S. solution becomes green,
& milky from S.



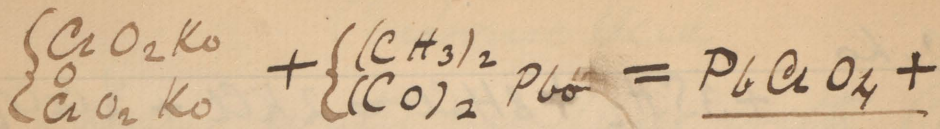
a dirty-green ppt.



yellow ppt of basic chromate slightly sol
in HCl & NO₂H₂

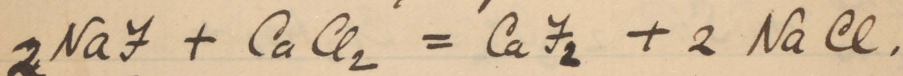


A purple-red ppt sol, (very slightly) in NO₂H₂
& more readily in Am H₂



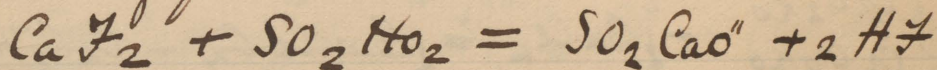
yellow ppt sol in OKH & sparingly sol in NO_2H_2 . insol in $\begin{cases} \text{CH}_2 \\ \text{CO}_2\text{H}_2 \end{cases}$

Hydrofluoric Acid.



clear gelatinous ppt.

Etching Test. if a dry fluoride is warmed in a Pt crucible with a little SO_2H_2 & the crucible is covered with a piece of glass, the latter will be eroded.

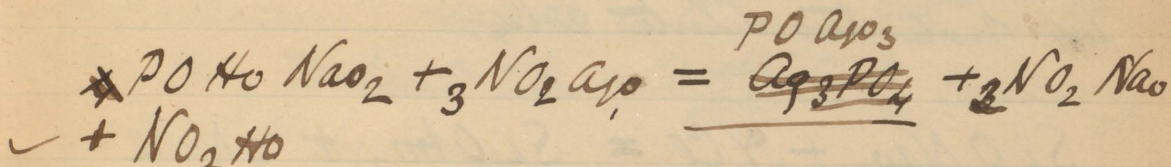


Phosphoric acid.

If Magnesium sulphide, mixed with enough Ammonic Chloride, to prevent pptation when Ammonia, is added. Be mixed with a sol of a phosphate

& excess of Am added, a white cryt- ppt
subsides

2

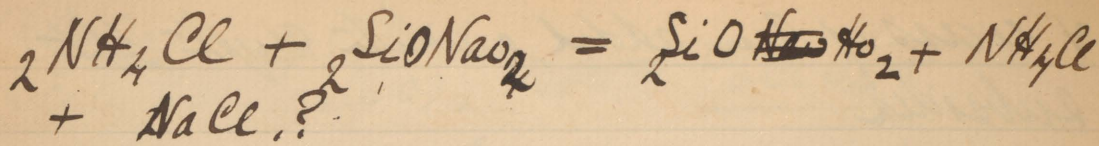


light-yellow ppt readily sol in NO_2H_2O &
Am H_2O .

If^{to} the substance to be tested (in sol) be added
concnt NO_2H_2O & then the sol of molybdate
of ammonia. a yellow ppt falls & leaves
the sol clear. (The liquid may be gently
warmed).

Silicic Acid. SiH_4O_4

A fragment of SiO_2 or a silicate
beated in a bead of microcosmic salt
remains undissolved & floats about as
a "skeleton"



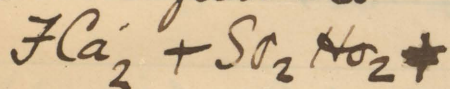
Hydrated silica separates easily on boiling, in not too dilute sols.

$\text{SiONaO}_2 + 2 \text{HCl} = \text{SiO}_2 + 2 \text{NaCl}$
 all acids act thus, the HCl must be added gradually or the ppt does not form. If the sol mixed with an excess of HCl & to be evaporated & heated the hydrated silica loses ~~and~~ water & changes to SiO_2 .

Decomposition of natural silicates.

By treatment with HCl , NO_2 , H_2O & SO_2 applicable to some silicates. First treated with the acid, then evap. to dryness & heated till no more acid fumes escape then moistened with HCl & filtered. The filtrate contains the metals the residue consists of the silica.

By treatment with hydrofluoric acid
applicable to all silicates, mix with 3
g fluoride of ammonium or 6 g fluoride
of calcium. Make into a paste with
 $\text{SO}_2 \text{H}_2$ & heat till all the SiO_2 passes off
as white fumes.



By fusion with $\text{Co Na}_2\text{O}$ & $\text{Co K}_2\text{O}$,
applicable to all silicates, fused mass
treated with OH_2 & HCl . evap to dryness &
heated till no more acid fumes escape
moistened with HCl heated with OH_2 &
filtered filtrate contains the metals.

Sulphuric acid.

Dry reaction.

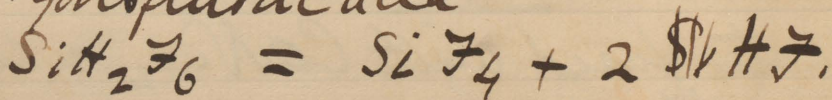
Sulphates fused with $\text{Co Na}_2\text{O}$ or charcoal
in inner blowpipe flame, are reduced to
sulphides, & give with HCl , upon silver a
black stain.

$SO_2 MgO'' + Ba Cl_2 = SO_2 BaO'' + 2 Cl Oug.$
white ppt insol in dilute HCl & $NO_2 Ho$

$SO_2 MgO'' + \begin{matrix} (CH_3)_2 PbO \\ (CO)_2 PbO \end{matrix} = SO_2 PbO'' + \begin{matrix} (CH_3)_2 \\ (CO)_2 MgO'' \end{matrix}$
Heavy white ppt sparingly sol in $NO_2 Ho$
but readily in strong HCl .

Free $SO_2 Ho_2$ mixed with a little cane
sugar may be detected in very small
quantities by evaporating the mixture
thus made, a black or blackish green
residue remains.

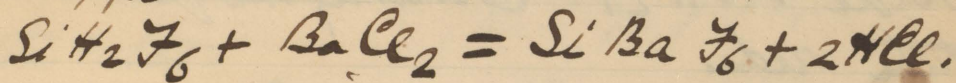
Hydrofluosilicic acid. $Si H_2 F_6$
When evaporated in platinum this acid
volatilizes completely as fluoride of silicon
& Hydrofluoric acid



When silicofluorides are heated with
strong $SO_2 Ho_2$ sulphates are formed

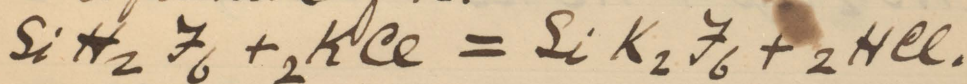
✓ Hydrofluoric gas & fluoride of silicon escape
 $\text{Si Ba F}_6 + \text{SO}_2 + \text{H}_2\text{O} = \text{Si F}_4 + 2\text{HF} + \text{SO}_2\text{BaO}$

Chloride of Barium gives with $\text{Si H}_2\text{F}_6$ a white ppt

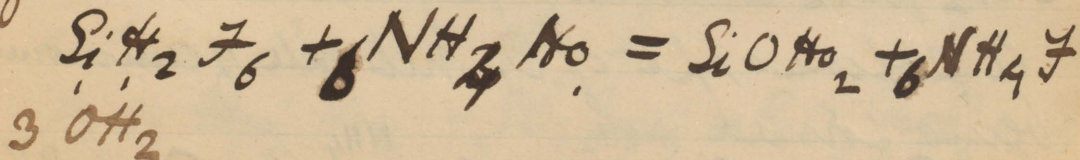


Chloride of Strontium gives no ppt but Plumbic acetate does.

Salts of Potassium ppt gelatinous silicofluoride of K.

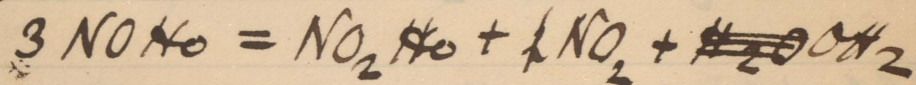


Ammonia in excess ppt's ~~it~~ hydrated silica, fluoride of ammonium being formed.

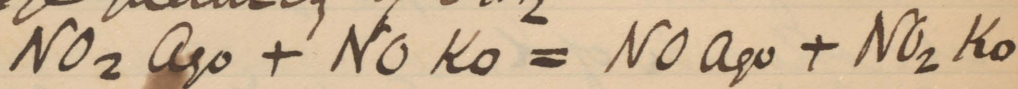


Nitrous Acid. NO KO

When a nitrite is mixed with an acid the nitrous acid formed splits up immediately into nitric acid nitric oxide & O_2 . Colouring the gas in the tube red.

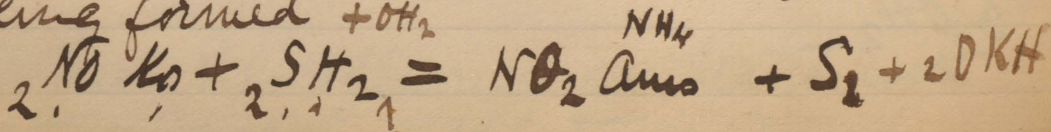


Nitrate of silver added to alkaline nitrite gives a white ppt - sol in a large quantity of O_2

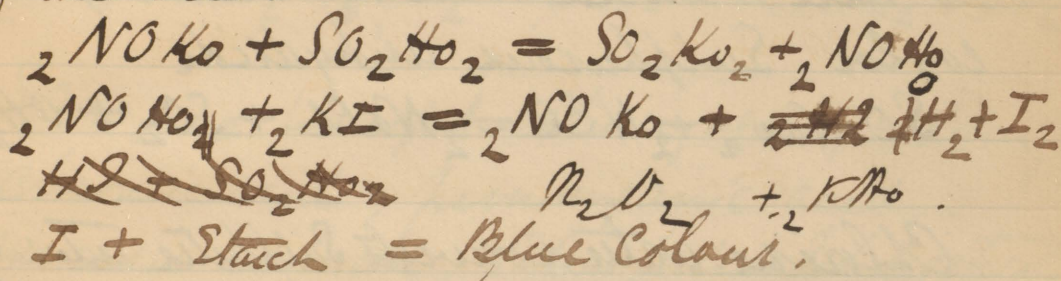


Ferrous sulphate upon addition of an acid gives a dark brown coloration

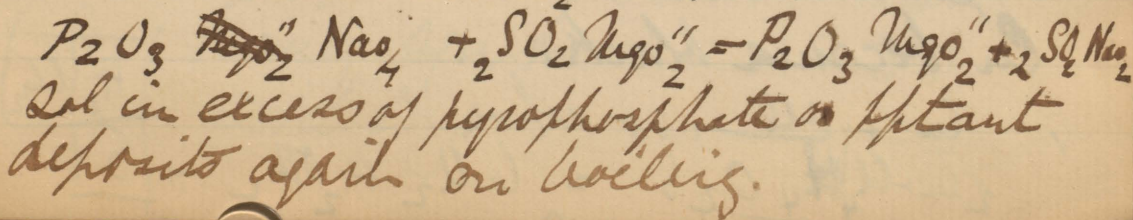
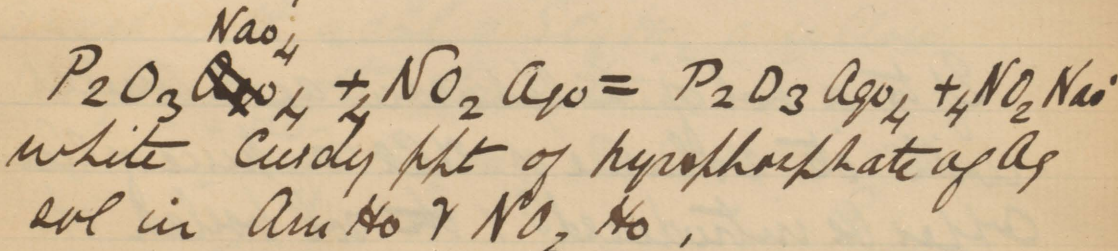
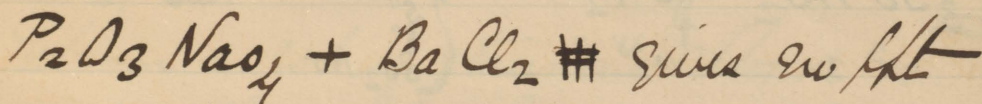
SH_2 gives when a drop of HCl is added a copious ppt of S , nitrate of ammonium being formed + O_2



The most delicate but not characteristic test is the blue colour formed in sol of nitrate when Potassic iodide, sol of starch, & SO_2 & H_2O_2 are added. a few minutes gives a colour in a sol containing only $1/100,000,000$ of the salt.



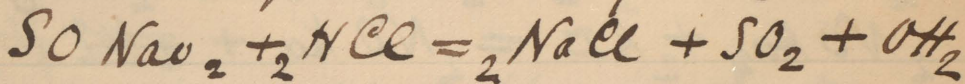
Pyrophosphoric acid (P_2O_5 NO_4)



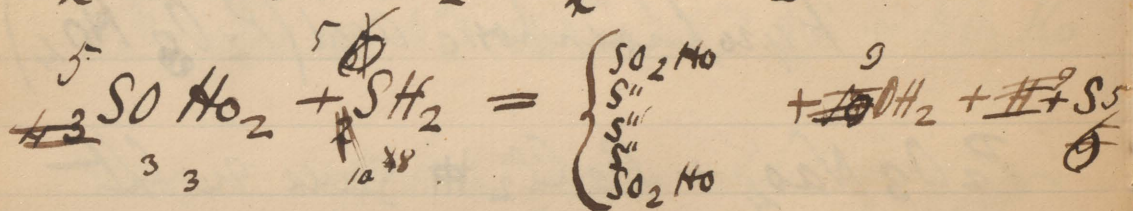
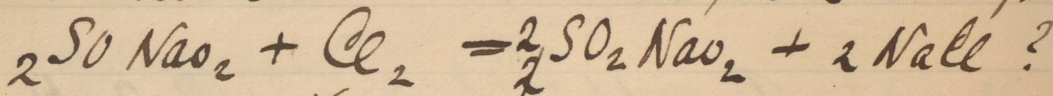
Molybdate of ammonia dissolved in NO_2 Ho give no ppt.

Sulphurous acid (SO Ho_2)

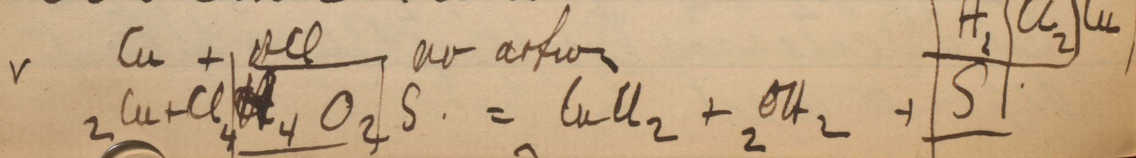
When treated with HCl all sulphites evolve Sulphurous anhydride



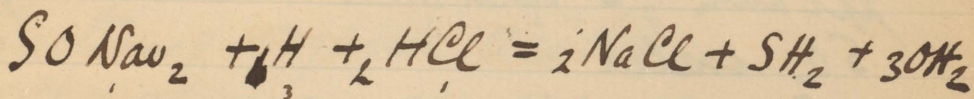
Chlorine water converts Sulphites into sulphates



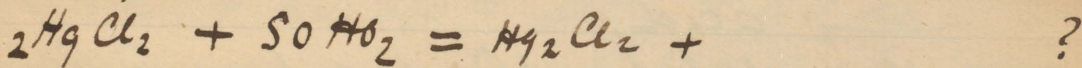
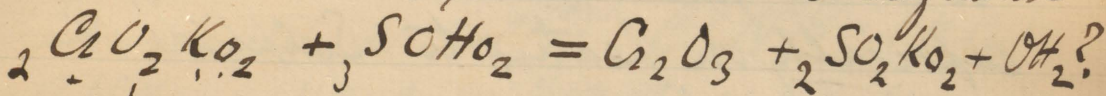
If to a vol of sulphurous acid mixed with its volume of HCl a piece of clean copper be introduced & the sol boiled the Cu becomes black.



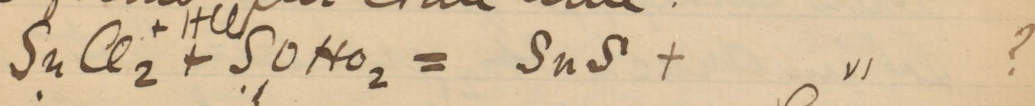
If a sulphite is introduced into a Hydrogen apparatus, SH_2 will come off with the H pptating a sol of plumbic acetate which has been pptated & dissolved in excess of OHK , black.



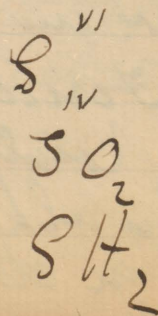
SO H_2 is a powerful reducing agent, reducing chromic acid, permanganic acid, mercuric chloride, & decolorises iodide starch.



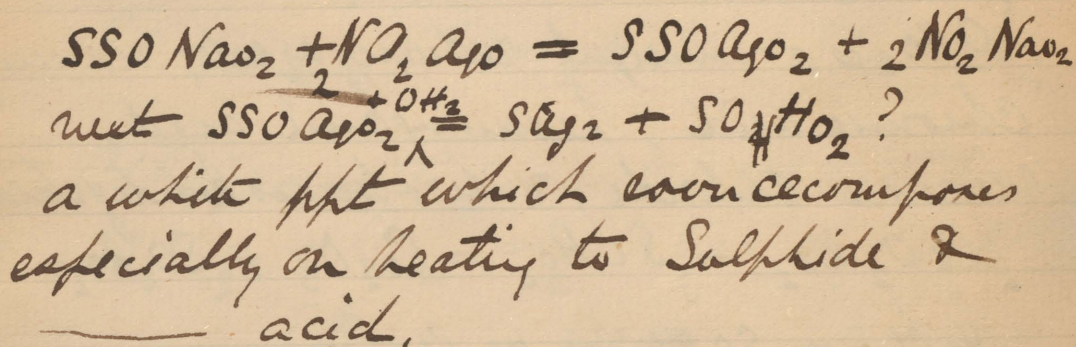
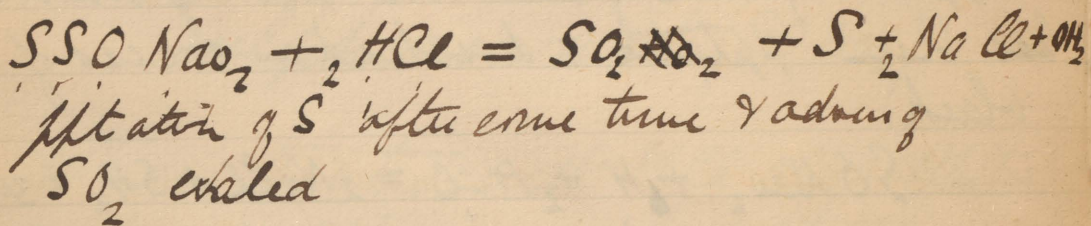
When a sol of stannous chloride is mixed with a sol of $\text{SO}_4 \text{H}_2$ a yellow ppt forms after some time.



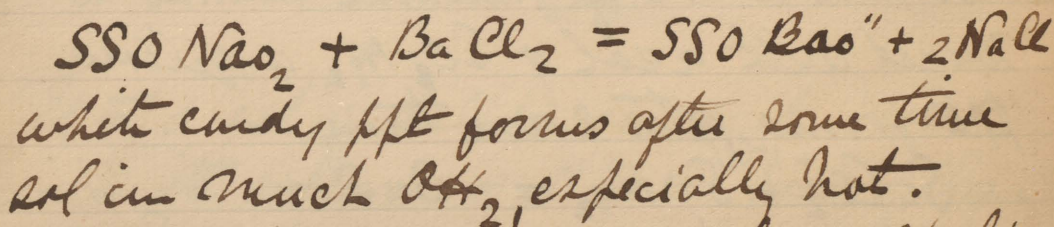
SO_2 Reducing agent
Oxidizing "



Hyposulphurous acid.
(SSO H₂O)

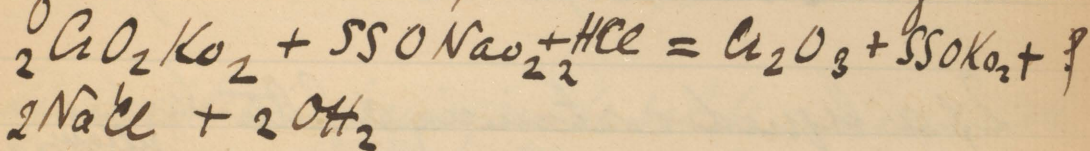


Hyposulphide of Na dissolves AgCl



Ferric Chloride colours sols of alkaline
hyposulphite reddish-violet (thus differs
from alkaline sulphides) becomes decoloured
on standing or by heating.

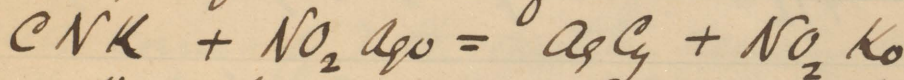
Hyposulphite immediately reduce an acidful sol of Chromic acid, & decolorize iodide starch.



Reactions of organic acids. of common occurrence.

Hydrocyanic acid
(HCN or HCN)

Employed a sol of CNK. (KCN)

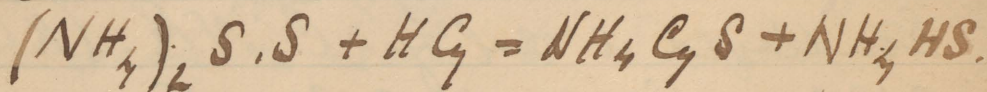


readily sol in excess of CNK. slightly sol in Am Ho & insol in $\text{NO}_2 \text{Ho}$

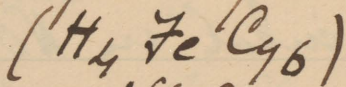
If ferrous sulphate & ferric chloride, are added to a sol of a cyanide acidified with HCl. no action takes place (liquid became slightly green) but when NaHo was added, a green ppt forms, consisting of Prussian blue & Ferrous-Ferric hydrate.

on addition of HCl the ferric hydrate
dissolves & the prussian blue is left.

If a liquid containing a little hydrocyanic
acid or a cyanide is mixed with ^{yellow} SAm_2
& Am_2O & heated till the excess of SAm_2
is decomposed or driven off & the mixture
acidulated with HCl & ferric chloride
added the characteristic blood red tint
appears.

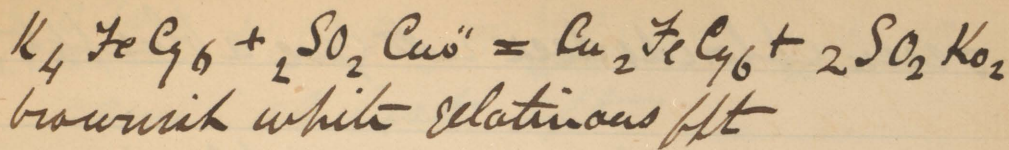


Hydroferrocyanic acid

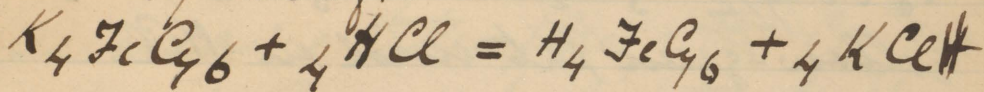


$\text{K}_4\text{FeCy}_6 + 4\text{NO}_2\text{Ag} = \text{Ag}_4\text{FeCy}_6 + 4\text{NO}_2\text{K}$
white ppt insol in Am_2O & NO_2H , but
sol in CNK.

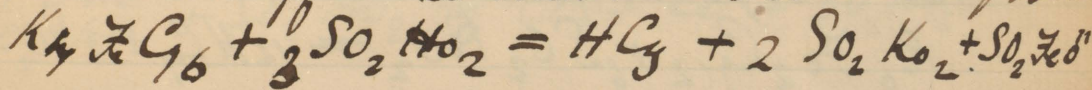
$\text{K}_4\text{FeCy}_6 + 8\text{Fe}_2\text{Cl}_6 = \text{Fe}_4\text{FeCy}_6 + 12\text{FeCl}_2$
a ppt of prussian blue.



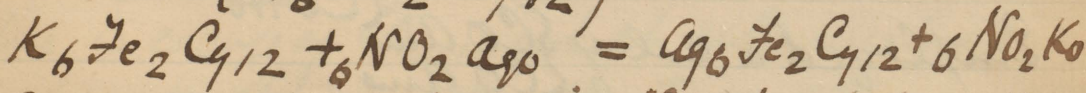
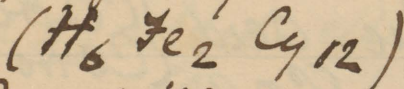
If an alkaline ferrocyanide sol be mixed with HCl & some ether added, hydroferrocyanic acid separates when the fluids meet in a minute crystalline form.



When ferrocyanides are heated with a mixture of 3 parts of ~~SO~~ SO₂ H₂O & 1 of O₂ hydrocyanic acid comes off & the metals remain as sulphates



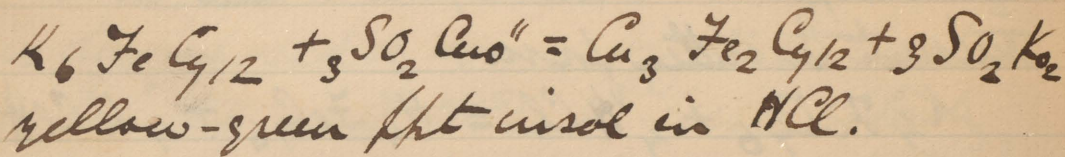
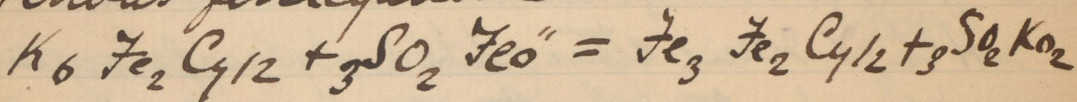
Hydroferrocyanic acid



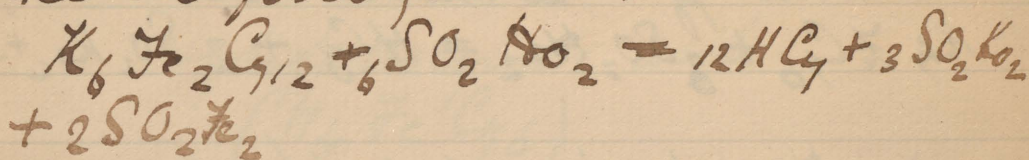
an orange ppt insol in NO₂ H₂O, but easily sol in Am H₂O & CNK.

Ferric chloride does not give a blue ppt

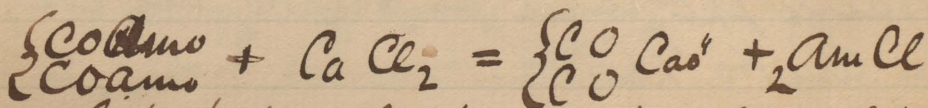
Ferrous sulphate produces a blue ppt of ferrous ferricyanide.



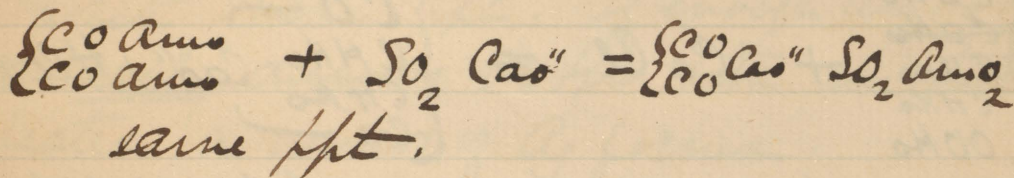
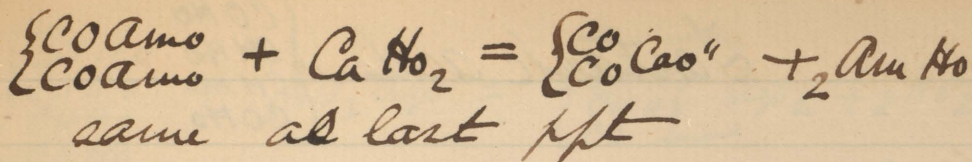
By heating a mixture of 3 parts of SO_2 & 2 parts of H_2 the Ferricyanides in decomposition like the ferrocyanides.



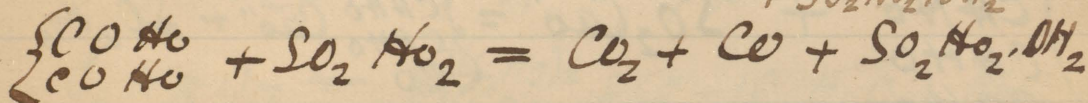
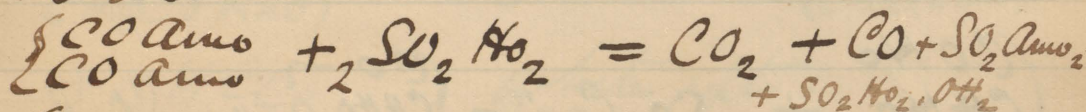
Oxalic acid $\begin{cases} CO H_2O \\ CO H_2O \end{cases}$
Employed a sol of $\begin{cases} CO AmO \\ CO AmO \end{cases}$



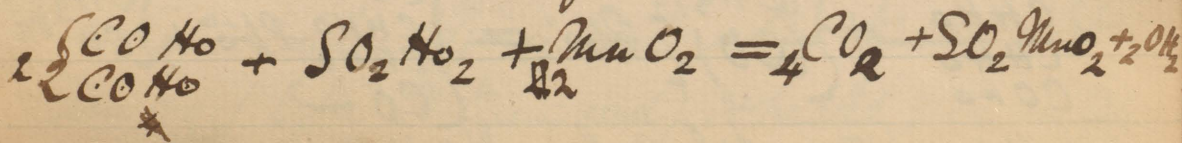
White pulverulent ppt insol in H_2O & almost insol in acetic & oxalic acids, sol in $HCl + NO_2 H_2O$

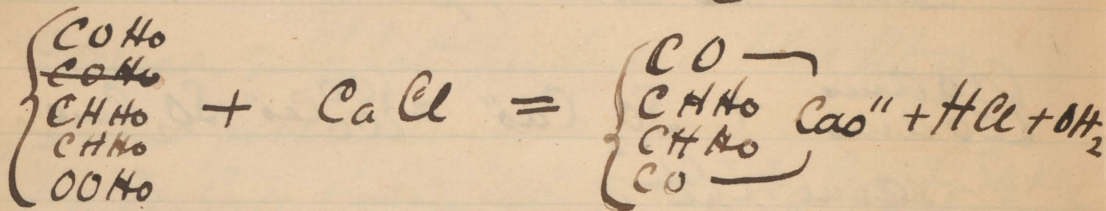
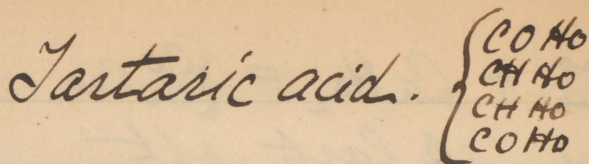


If a dry oxalate be heated with strong $\text{SO}_2 \text{ Ho}_2$ effervescence takes place & ~~the~~ CO_2 & CO escape, the CO may be lighted at the end of the test-tube

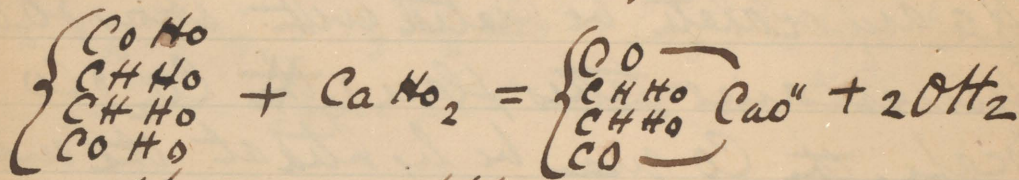


If an oxalate is mixed with MnO_2 & $\text{SO}_2 \text{ Ho}_2$ & OH_2 added effervescence will occur due to escape of CO_2 , which extinguishes a light at the mouth of the test-tube.

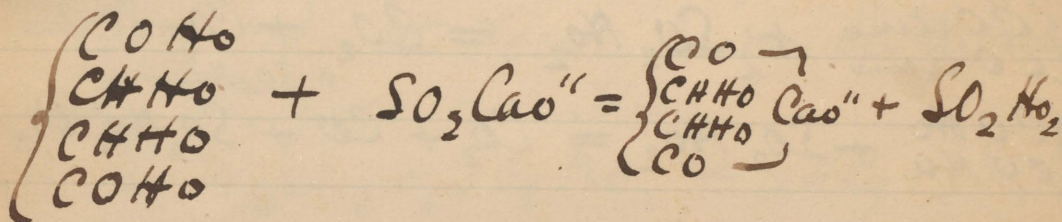




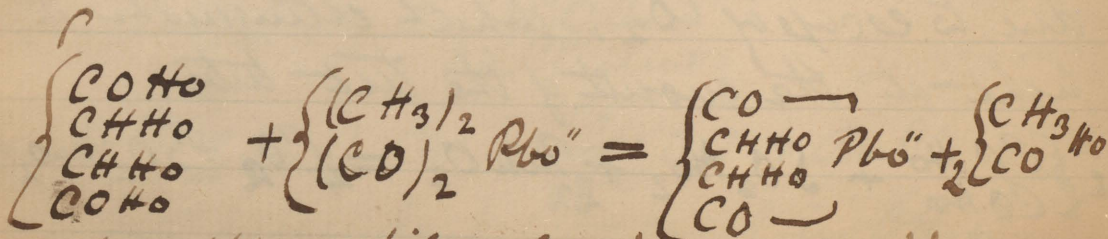
comes down on stirring. white crysl = ppt.



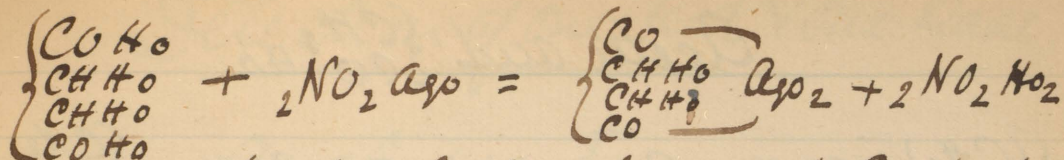
the same ppt.



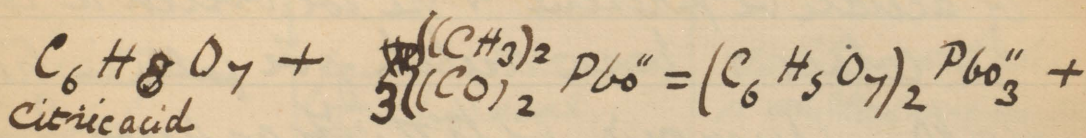
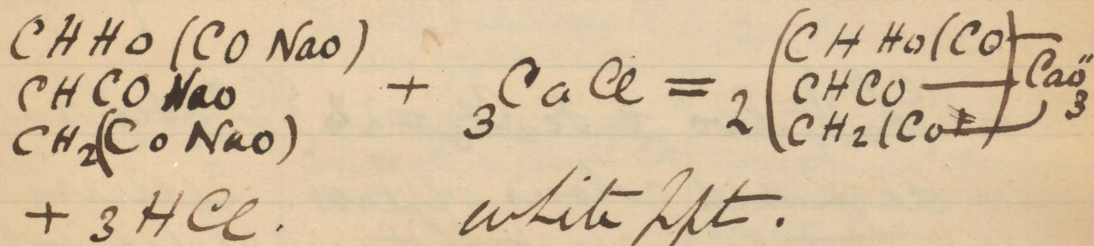
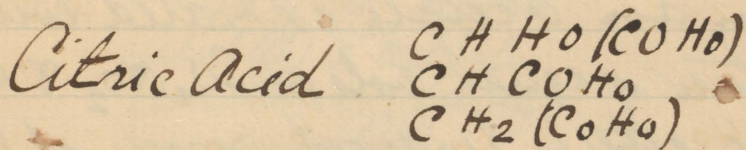
Acetate of Potassium & free acetic acid produce a sparingly sol ppt on stirring.



white ppt readily sol in $\text{NO}_2 \text{HO}$ & Am HO



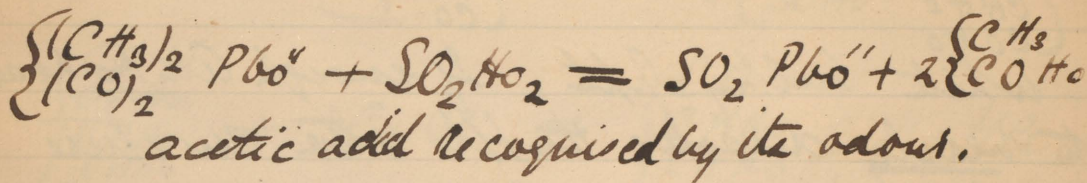
white bulky ppt. If enough Am Ho be added to nearly dissolve the ppt & the mixture heated a mirror of Ag forms.



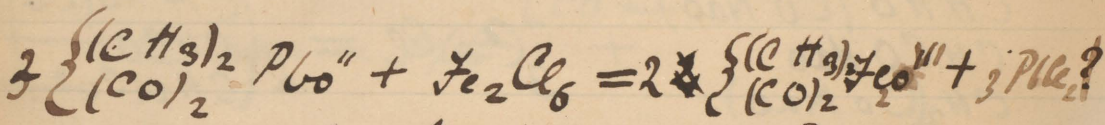
$3 \begin{matrix} \text{CH}_3 \text{ Ho} \\ \text{CO Ho} \end{matrix}$ readily sol in Am Ho, after being washed.

$\text{C}_6 \text{H}_8 \text{O}_7 + 3 \text{NO}_2 \text{AgO} = \text{C}_6 \text{H}_5 \text{O}_7 \text{Ag}_3 + 3 \text{NO}_2 \text{Ho}$
white bulky ppt which when treated with Am Ho (like Tartaric acid) & heated gives no ~~no~~ metallic mirror.

Acetic acid $\left\{ \begin{array}{l} \text{C}^{\text{H}_3} \\ \text{CO} \end{array} \right. \text{H}^{\text{O}}$



When an acetate is heated with a mixture of equal vols of $\text{SO}_2 \text{H}^{\text{O}_2}$ & $\text{C}_4 \text{O}_6 \text{H}$ acetic ether is produced, recognised by its smell.



dark red colour appears. If excess of acetate be present & the sol boiled it loses its colour & basic acetate of Fe falls in brown flocks. Ammonia ppt the Fe as ferric hydroxide. HCl added to the sol decolourises it.
(Here ferric acetate difs from ferric sulpho-cyanide)

Detection of one Acid & one Base.

Analysis I

Experiment	Observation	Inference
<p>Observation preliminary</p> <p>heated in tube</p>	<p>Gave off H_2, alkaline (slightly) to test paper whitened & finally became black.</p> <p>partly volatilized?? & gave off CO & CO_2</p>	<p>Oxalic acid</p>
<p>treated residue with HCl</p>	<p>it effervesced, while the original did not</p>	<p>An organic acid combined with an alkaline or alkaline earthy base</p>
<p>II heated on charcoal</p>	<p>fused & ran into the charcoal</p>	<p>salt of alkalis or alkaline earths.</p>
<p>III heated in crucible flame</p>	<p>coloured outer fl violet.</p>	<p>K</p>

Confirmation of base

Added Am K_2 & CO Am O_2 gave no ppt, abs of Ba, Ca, Sr. Added $PtCl_4$ gave yellow crypt ppt, must be Am or K. ignited ppt on Pt foil, dissolved residue in H_2O & added NO_2 also - gave ppt of $AgCl$ = K

examination for acid.

Experiment	Observation	Inference
Heated a little got solid with HCl	no action	
Heated with dilute SO ₂ H ₂ O	no action	
Heated with concentrated SO ₂ H ₂ O	CO & CO ₂ all evolved without blackening	{ CO H ₂ O (Oxalic ac) CO H ₂ O
Confirmed by passing the gases through Ca H ₂ O, gave a white ppt CO₂	gave a white ppt CO₂	CO ₂
Heated with blue flame	burned with blue flame	CO

Confirmed acid by pptating with Ca Cl₂
gave white ppt.

Potassic Oxalate

Experiment	Analysis II	Inference.
Heated in tube	fused & gave off O_2 of crystallization	probably a salt of the alkalis, or alkaline earths
Heated on Charcoal	fused & then left a white infusible mass alkaline to litmus.	Ba Sr Ca Mg
Confirmed by adding CO , NO_2 , CO_2 & heating. NO_2	a flesh coloured mass left	Mg.

By wet way.
 Added HCl & heated gently, no ppt.

Abs of	Added SH_2 & heated gently, no ppt.	Added $AmCl$, AmH_2O , & SAm_2 no ppt	Added AmH_2O & CO AmO_2 no ppt	
$AgCl$	Abs of As_2S_3 PbS HgS CuS Bi_2S_3 CdS SaS S_2S_2 Si_2S_3 Si_2S_5 As_2S_3 Am_2S_3 PtS_2	Abs of CoS NiS ZnS MnS FeS $Cr_2H_2O_6$ $Al_2H_2O_6$	Abs of $CaBa$ Sr Ca	
$PbCl_2$				Must be K Na $Mg.$
Hg_2Cl_2				

Added AmH_2O . gave white ppt, sol in $AmCl$ = Mg

Added $AmCl$ & AmH_2O . no ppt. but on adding PO_4 & Na_2O_2 a white cryt ppt. = Mg.

Examination for Acid

Experiment	Observation	Inference
Tested a little of solid with dilute HCl	no action	
Treated with dilute $\text{SO}_2 + \text{H}_2\text{O}$	no action	
Treated with concentrated $\text{SO}_2 + \text{H}_2\text{O}$	no action	

I added dilute HCl to a portion.
Tested with BaCl_2 . gave a white heavy ppt insol on boiling = $\text{SO}_2 + \text{H}_2\text{O}$

Magnesium Sulphate

Analysis III.

Experiment	Observation	Inference
<p><u>Heated in tube</u></p> <p><u>Heated on charcoal</u></p>	<p>no reaction, evolved CO_2 evolved</p> <p>left res. left</p> <p>left a white mass</p> <p>gave a alkaline to litmus</p>	<p>Carbonate of alk. earths.</p> <p>Ba Sr Ca Mg</p>

In the Wet way
Dissolved in HCl. +

Added S^{+2} no ppt

<p>Abs of</p> <p>PbS</p> <p>HgS</p> <p>CuS</p> <p>Bi_2S_3</p> <p>CdS</p> <p>SuS</p> <p>Sn^{+2}S_2</p> <p>Sb^{+2}S_3</p> <p>Sb^{+3}S_5</p> <p>As_2S_3</p> <p>As_2S_5</p> <p>PtS_2</p>	<p>Added AmHo, AmP, AmCl no ppt</p> <p>Added AmHo & CO AmO₂ ppt.</p> <p>Must be Ba, Ca, Sr,</p> <p>Added SO_2 CaO to sol. gave no ppt = Ca</p> <p>Added $\text{Si}^{+2} \frac{7}{6}$ to sol gave no ppt = Ca</p>	<p>Abs of</p> <p>CoS</p> <p>NiS</p> <p>FeS</p> <p>MnS</p> <p>ZnS</p> <p>Cr^{+3}O_3</p> <p>Al^{+3}O_3</p>	<p>must be in Ni Ho</p>	<p>Co AmO</p> <p>Co AmO</p>
--	--	--	-------------------------	-----------------------------

Examination for acids

Experiment	Observation	Inference
Added a little of solid substance to HCl dilute	gave effervescence of gas, which extinguished flame & ppt lime with (CaCO ₃)	CO ₂
SO ₂ test	Same	

Calcic Carbonate (CaCO₃)

Analysis of the ~~test~~

Exp	Obs	Infer.
Heated in tube	fused, gave off water & NH ₃ alkaline to lit paper	Probably a salt of alkalis or alkaline earths, combined with cyanogen, or organic matter.
Heated on charcoal	Fused & sank in also degenerated coloured outer purple black	salt of alkalis or alkaline earths combined with nitrate chlorate etc
In inner flame		K

Added HCl no ppt

Abs of	Added H ₂ no ppt.	Added AmCl Sam ₂ Am No. gave no ppt	Added Am No & AmCl O no ppt	Must be
AgCl	Abs of SnS SnS ₂ Sb ₂ S ₃ Sb ₂ S ₅ As ₂ S ₃ As ₂ S ₅ Au ₂ S ₃ PtS ₂	Abs of ZnS PbS BiS NiS MnS ZnS Al ₂ O ₃ Cr ₂ O ₃	Abs of Ca Ba Sr	K Na or Mg or Am.
Hg ₂ Cl ₂				
PbCl ₂				

Tested with PtCl_4 gave heavy yellow crypt
ppt = K or Am

Collected ppt & heated it to redness on Pt foil
gave then dissolved residue in H_2O ; gave a ppt
with ~~HCl~~ NO_2 also = K.

Examination for acids.

Ex	Obs	Inf
Heated with dilute HCl	gave off HCl recognized by its odour.	Cyanide

Confirmed by adding NO_2 also ~~to~~ white curdy
ppt must be, HCl or HCy .

Collected ppt washed, & ignited in a porcelain
crucible, dissolved residue in NO_2 H_2O & tested
with ~~NO_2 also~~ HCl gave a white curdy ppt
of AgCl . HCy .

Potassic Cyanide (CNK).

Analysis 5th

Ex	Obs	Inf
Heated in tube	no change	
Heated on charcoal gave metallic Confirmed by heating with CO_2 & CNK .	gave metallic globs. gave a malleable globule, with brown incrustation when wet with water	Pb.

In the wet way.
Dissolved globule in NO_2 & H_2O
Added HCl . white ppt.

Must be PbCl_2 Hg_2Cl_2 AgCl	Confirmed by adding AmH_2O gave a white ppt. Pb. Confirmed by adding SH_2 gave a black ppt. Pb.
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Examination for acid

Ex	Obs	Inf
Heated with HCl	no action	
Heated with SO_2 & H_2O	no action	
Heated with concn SO_2 & H_2O	no action	

Boiled substance in CO_2NaO_2 filtered &
acidulated one portion of filtrate with HCl
Added BaCl_2 gave white ppt insol on
boiling. SO_2 H_2O_2 .

Confirmed by heating substance in inner
bp flame on charcoal, & testing the residue
with a drop of acid on silver gave black
stain SO_2 H_2O_2 .

Plumbic Sulphate (SO_2PbO)

