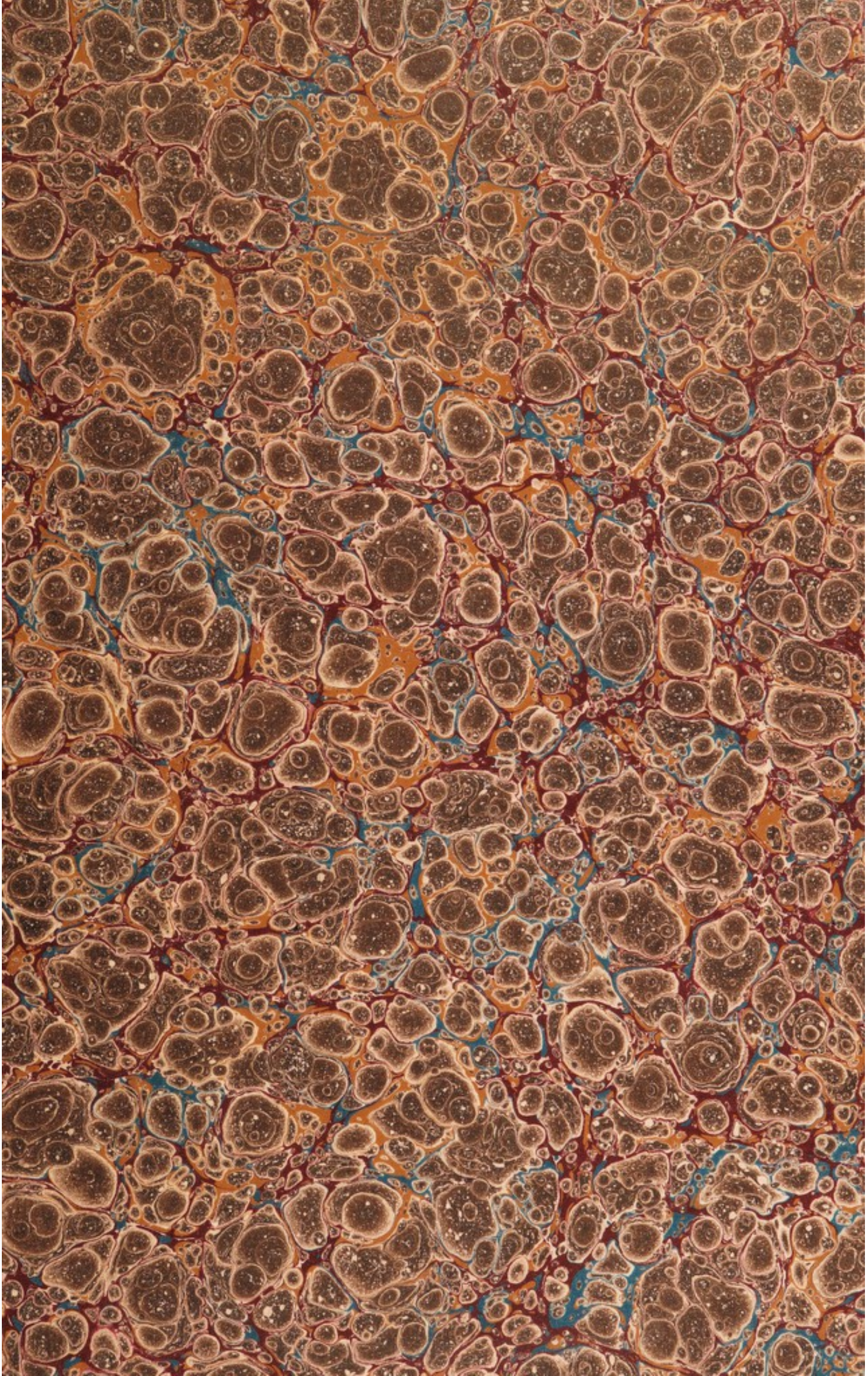
Experiments and observations to investigate the nature of a kind of steel, manufactured at Bombay, and there called wootz: with remarks on the properties and composition of the different states of iron / By George Pearson.



Dr. Pearson
from the Author

EXPERIMENTS AND OBSERVATIONS

TO INVESTIGATE THE

COMPOSITION

OF

JAMES'S POWDER.

By GEORGE PEARSON, M. D. F. R. S.

From the PHILOSOPHICAL TRANSACTIONS.

A

EXPERIMENTS, &c.

Read before the ROYAL SOCIETY, June 23, 1791.

THE medicine upon which many phyſicians principally depend in the cure of continued fevers is JAMES's *Powder*; but, although it has been very extenſively uſed above thirty years, the public have not, I believe, been informed of the particular nature of this ſubſtance. This *powder* was originally a patent medicine; but it is well known that it cannot be prepared by following the directions of the ſpecification in the Court of Chancery. Preſuming that I have made ſome experiments and obſervations which may explain the nature and manner of preparing this medicine, and, perhaps, may extend the hiſtory of antimony; I beg leave to have the honour of preſenting an account of them to the Royal Society.

Senſible properties of JAMES's *Powder.*

Some parcels of this preparation are white, but in general it has a yellowiſh caſt; and this ſhade is more evident in ſome ſpecimens than in others. It is ſaid, that this powder cannot, in general, be made at different times of preciſely the ſame ſhade of yellow or degree of whiteneſs. Sometimes with the aid of a lens a few very ſmall ſhining *ſpicula* are ſeen mixed with powder. When preſſed between the fingers it feels

ſmooth, with ſome rather rough particles, and it is gritty in the mouth. Moſt parcels at firſt are taſteleſs; but in about a minute there is a ſlight braſſy taſte. It is perfectly inodorous.

Specific gravity.

This powder feels much heavier than any of the common earths and ſtones in a pulverized ſtate. One of the phials, nearly full, in which it is ſold, reckoned to hold a quantity equal to twelve packets, or 480 grains, contained 470 grains troy weight of JAMES's powder. This phial, filled with diſtilled water to the ſame height that it had been by the powder, was found to contain nearly four drachm-meaſures, or about 240 grains, of this liquid *.

Effects of fire.

(*a*) The exterior part of the flame of a candle applied, by means of the blow-pipe, to about one, two, and three grains of JAMES's Powder on charcoal, and alſo in the ſpoon, only made it yellowiſh while hot, but, on cooling, this colour diſappeared. The interior and hotteſt part of the blue flame turned this powder yellow, and when continued ſo as to ignite it, a white inodorous fume or vapour aroſe, which ſoon ceaſed; and though the heat was continued, the powder neither appeared to diminiſh nor melt; but, on cooling, a ſlightly co-

* After this Paper had been read, an experiment, in a different manner, was made to aſcertain the ſpecific gravity of this powder. The quantity which nearly filled a phial weighed 437 grains; and filling the ſame phial, to the ſame height, with diſtilled water, the temperature of which was 65°, the water weighed 250,2 grains. The reaſon of the variation in theſe reſults, in making uſe of different parcels of this medicine, will be obvious, from the following account of its preparation, and the great difficulty of determining, with accuracy, the ſpecific gravity of powders.

hering

hering white ſolid, about three-fourths of the original weight of the powder, was left. If the flame was ſuddenly withdrawn, as ſoon as the white fumes appeared, they aſcended with a kind of revolving motion.

(*b*) Two grains of this powder, mixed with about three of pulverized tartar, being expoſed on charcoal to flame applied by the blow-pipe, the mixture turned black, boiled, and ſwelled; and by continuing to apply the flame, the coaly matter of the tartar diſappeared, a part of the mixture fuſed, and in that ſtate ſeveral ſmall, ſilvery, apparently metallic grains were perceived. On cooling, they were ſeen with the naked eye, or with a lens, adhering to an irregularly figured, partially melted, whitiſh maſs. On a ſecond application of the flame, theſe metallic globules diſappeared.

(*c*) JAMES's Powder, with glaſs of phoſphoric acid, melted into an opaque yellowiſh globule while hot, which on cooling grew whitiſh.

(*d*) This Powder, with ſeveral times its weight of melted borax, afforded a colourleſs tranſparent glaſs while fluid; but, on adding a larger proportion of powder, the globule turned opaque, and when cold became of a milky whiteneſs. As the JAMES's Powder mixed, or melted, with the fuſed ſalt, ſlight exploſions were ſeveral times heard.

(*e*) With foſſil alkali, in the ſpoon, this powder apparently fuſed, and afforded a colourleſs tranſparent fluid in a ſtate of rotatory motion; but on cooling it grew opaque, and had a horny appearance.

(*f*) 100 grains of this powder in a two-inch Engliſh crucible, the cover of which was luted on it as cloſely as poſſible, were expoſed above two hours to a fierce fire in a melting furnace. On breaking this crucible, when cold, the powder was found

found changed into an entire very hard white ſolid, receiving its figure from the veſſel, and weighed 95 grains. On breaking this hard ſolid, the lower part of it ſeemed to be vitrified, or in a ſtate of enamel; and being powdered, it afforded a much whiter powder, and of greater ſpecific gravity, than before. The degree of fire denoted by WEDGWOOD's pyrometer was 166°.

Theſe experiments indicated the preſence of a metallic calx, a part at leaſt of which was that of antimony, mixed with earthy matter.

Experiments with different menſtrua applied to JAMES's *Powder.*

I. *With water.*

300 grains of this powder were digeſted for ſeveral hours in twenty-ſeven ounces of diſtilled water, and then boiled for one hour. While boiling the water appeared milky; but in half a minute's time, after withdrawing the lamp over which it boiled, the liquid became nearly clear, and the ſediment depoſited was apparently the powder undiminiſhed in quantity, and in other reſpects unaltered. While hot the liquid was decanted upon a filter of ſeveral folds of paper previouſly weighed, through which twenty ounces of quite clear liquid, like water, readily paſſed. Very little powder could be perceived on the filter; but when it was well dried, it weighed fourteen grains more than before the experiment. The filtered liquor was taſteleſs. In about three quarters of an hour it grew ſlightly *turbid*, and in ten minutes after became *milky*. On ſtanding eight days longer, the milkineſs diminiſhed, and a ſmall quantity, perhaps four grains, of cloſe white ſediment, firmly adhering to the ſides of the veſſel, were depoſited. A little of this ſlightly milky fluid being made hot, it grew quite clear, and on cooling turned

turned milky as before, or depoſited a ſediment; therefore, this milkineſs depended on cold water diſſolving a ſmaller proportion of JAMES's Powder than hot water. The whole of the filtered milky liquor was poured upon a filter as before, through which it paſſed without any diminution of its turbid appearance; and, on drying, the filter was found to have increaſed only a quarter of a grain in weight. Some of the vapour that aroſe during the ebullition being condenſed was found to be pure water.

On a repetition of this experiment the phænomena above related were always obſerved; but the ſemi-vitrified JAMES's Powder above-mentioned (*f*) afforded a much leſs milky fluid and ſediment than the powder uſed in the preceding experiment.

In order to determine the kind of ſubſtances in water after boiling in it JAMES's Powder, the following re-agents were added to the above filtered liquor.

1. Acid of ſugar ſometimes occaſioned immediately more turbidneſs, and at other times tranſparency was inſtantly produced; but in all caſes, on ſtanding, more ſediment fell than from the filtered liquor alone.

2. Muriated barytes in about an hour rendered this liquid evidently more turbid, and on ſtanding more ſediment was depoſited than from the filtered liquid to which nothing had been added.

3. Lime-water occaſioned immediately a curdy appearance.

4. Infuſion of turnſole was ſometimes turned to a ſlight red; but in general it was not altered in colour.

5. Nitre of ſilver produced in a few hours a ſlight ſediment.

6. Pruſſianated alkali of tartar occaſioned no alteration immediately, nor for four days after adding acetous acid to this mixture.

7. Mild alkali of tartar, and likewiſe mild foſſil alkali, though boiled in this liquor, did not occaſion any additional precipitation.

The ſediment that fell, on merely ſtanding, from the above filtered liquid, was next examined.

1. It did not diſſolve in 100 times its weight of boiling hot concentrated acetous acid; nor,

2. Was it apparently acted upon by boiling with mild alkali of tartar; for, after decanting the clear liquid of this mixture, the ſediment from it was not diſſolved by a large quantity of acetous acid, but readily by marine acid.

3. This ſediment immediately diſappeared on pouring upon it a much ſmaller quantity of marine acid, and alſo of acid of nitre, than had been applied of acetous acid, without any ſolution enſuing.

4. To one portion of this ſolution in marine acid juſt mentioned, was added gradually lixivium of alkali of tartar; after the effervescence had ceaſed to be produced, the firſt drop occaſioned a turbid appearance, and the liquid did not grow clear again on adding a large proportion of vinegar to make it ſour.

5. Another portion of this ſolution in marine acid, being boiled to carry off the ſuperabundant acid, was poured into a large proportion of lime-water, by which it was rendered cloudy, and did not become clear again on adding concentrated acetous acid to make it ſour.

6. To a third portion of this ſolution in marine acid, from which the redundant acid had been carried off, twenty drops of Pruſſian alkaline lixivium were added, which immediately turned it of a bluiſh caſt without diſturbing its tranſparency; and, after ſtanding four days, a ſmaller quantity of pale blue

ſediment

ſediment was depoſited than had fallen from a quantity of diſtilled water equal to this muriatic ſolution, to which had been added twenty drops of this Pruſſian alkaline lixivium, and one-fourth part of a drop of muriated antimony. The ſame Pruſſian alkali mixed with vinegar, on ſtanding, turned bluiſh, but depoſited nothing.

7. Though the ſediment that fell in the filtered fluid, p. 4. on merely ſtanding, diſſolved in the nitrous acid as above mentioned; yet, when this acid was added in a ſmaller proportion, but to render the mixture ſour, a partial ſolution only took place. On adding, however, a very ſmall quantity of marine acid, the ſolution was total, and with leſs ſuper-abundance of this menſtruum than of the nitrous acid in which a part remained undiſſolved. This ſolution

(*a*) With water depoſited Algaroth powder:

(*b*) With Pruſſian alkali turned bluiſh, and, on ſtanding, a ſmall quantity of ſediment took place.

(*c*) A bright plate of copper, immerſed in this ſolution, did not appear to be at all whitened, or rendered paler.

(*d*) Muriated barytes rendered this ſolution very turbid inſtantly.

(*e*) Acid of ſugar produced no change, except in two or three days a very minute portion of ſediment; but the ſaccharated ſoda immediately occaſioned a ſlight precipitation.

(*f*) Alkali of tartar, fully aërated, rendered this ſolution ſlightly turbid; but cauſtic mineral alkali induced no change.

(*g*) Lime-water, in a ſmall proportion, did not affect the tranſparency; but in a larger produced copious clouds.

The JAMES's Powder which afforded the ſolution in water, on which the experiments above related were made, was boiled a ſecond time in eighteen ounces of diſtilled water for

two hours. The decanted and filtered liquid on cooling grew leſs turbid than before, p. 4. and depoſited leſs ſediment. The filter, on drying, was found to have gained ten grains, though very little powder could be ſeen upon it. The experiments above related, were made on this filtered liquor, and in a ſlighter degree the ſame appearances were obſerved.

The JAMES's Powder remaining after theſe experiments, being well dried, weighed 260 grains, and therefore was found to have loſt 40 grains, partly by ſolution in water, but ſtill more by its adhering to the filters.

I wiſhed to know the proportion in which JAMES's Powder diſſolved in water; and therefore evaporated, in a very thin light glaſs pan, previouſly weighed, twenty-four ounces of the filtered liquids, p. 4. and p. 8. Very little precipitated matter appeared till nearly the whole of the liquor was evaporated; and, when the whole was carried off, a taſteleſs whitiſh, leafy, or mica-like ſediment, but in ſome parts black, was left, that weighed ſix grains. This ſediment required above 100 times its weight of hot water to diſſolve it. It was boiled in 500 times its weight of diſtilled water, and it paſſed through ſeveral folds of filtering paper rather turbid even while hot; nor could it be rendered clear by repeated filtration through paper. This filtered liquid,

(*a*) With infuſion of turnſole and turmeric, betrayed no alkaline ſubſtance, nor deciſively any acidity.

(*b*) Lime-water rendered it curdy; and on adding vinegar, it grew milky.

(*c*) With acid of ſugar it grew clear; but, on ſtanding, was more turbid than before.

(*d*) Salited

(*d*) Salited barytes made it inſtantly turbid.

(*e*) Alkalies, mild and cauſtic, induced no change.

(*f*) Pruſſian alkali produced only a clear greeniſh colour, after the addition of vinegar, and long ſtanding.

(*g*) A very ſmall quantity of marine acid rendered it quite clear; but it required much more nitrous acid to produce this effect; and this mixture did not whiten copper.

(*h*) With nitre of ſilver the filtered liquor turned of a ſomewhat bluiſh hue, and afterwards curdy.

The undiſſolved matter that remained on the filter, p. 8. l. 22. above mentioned, appeared, on examination, to be the ſame kind of ſubſtance, with a larger proportion of iron, as that which was diſſolved by water, the experiments on which have been juſt mentioned. In particular, it afforded Algaroth powder, but did not whiten, in the ſmalleſt degree, a copper plate.

The following concluſions may, perhaps, be juſtifiably drawn from theſe experiments on JAMES's Powder with water.

1. That the whole, or a part, is ſoluble, or at leaſt may be ſuſpended, in about 2000 times its weight of pure water cold; and in about half this quantity of boiling water.

2. That this ſolution contains calcareous earth united to an acid, or ſome other ſubſtance, from which it cannot be diſunited by cauſtic or mild fixed alkalies; therefore, the precipitation by muriated barytes cannot be referred to vitriolated lime.

3. That this ſolution contains a metallic calx, a part of which at leaſt is that of antimony uncombined, or at leaſt not united to any acid with which it forms a compound ſoluble in water.

4. That

4. That the ſubſtance in the nitrous ſolution of the part of JAMES's Powder that had been diſſolved in water, which precipitates lime from lime-water, and which precipitate is not ſoluble in a large quantity of vinegar, is, probably, phoſphoric acid from phoſphorated lime decompoſed by nitrous acid.

The precipitation by muriated barytes and nitrated ſilver could not be from vitriolic and marine acids conſiſtently with the preceding experiments; and I could not have conjectured what was the ingredient in JAMES's Powder which occaſions it, if I had not found, that muriated barytes is not only a teſt of vitriolic but of phoſphoric acid united to lime and alkalies; and the acid of phoſphorus will alſo produce a turbid appearance with nitrated ſilver. The calx of iron, in the above experiments, is in perhaps too ſmall a quantity to be conſidered in any other light than as an accidental ſubſtance.

II. *With acetous acid.*

The 260 grains of JAMES's Powder, remaining after boiling 300 grains of it in diſtilled water, and after the unavoidable waſte of it in the above experiments with water, were put into a tubulated retort that would contain four ounce-meaſures, on which were poured three ounces of concentrated acetous acid, the ſpecific gravity of which was as 106 to 100, the neck of the retort being immerſed in quickſilver, and the tubulated part being immediately cloſely ſtopped. No effervescence was perceived; nor did any elaſtic fluid riſe during twenty-four hours into an inverted veſſel of quickſilver; and when heat was applied to boil the acid, nothing but the common air of the retort and a little water and acetous acid came over.

This

This mixture of acetous acid and powder being poured, while hot, on a filter of two folds of paper, a clear and colourleſs liquid paſſed through, that remained ſo, when cold, without any ſediment. The filter, with the powder upon it, being well dried, weighed ten grains more than the ſum of their weight ſeparately before the experiment; but the powder being carefully ſcraped off weighed only a little more than 240 grains, and appeared to have ſuffered no change in its properties.

This filtered liquor was ſubjected to diſtillation; it remained clear till about half of it had come over: but then it became rather turbid, and grew more ſo to the end of the diſtillation. There remained in the retort apparently four or five grains of brown ſediment, that adhered very cloſely to the bottom and ſides of it, nearly half as high as the liquid reached.

1ſt, This acetous acid, in which JAMES's Powder had been boiled, and afterwards diſtilled, was found to contain no earth, ſalt, or metallic matter: nor did the acid itſelf appear to be altered in its chemical qualities.

2dly, The reſiduum in the retort had no taſte. It did not appear to diſſolve by trituration in one ounce of diſtilled water, nor in lixivium of alkali of tartar, mild or cauſtic. After boiling this reſiduum in one and a half ounce of water, part of it ſeemed to be diſſolved; and this ſolution being filtered was examined with the following re-agents.

(*a*) Acid of ſugar rendered it turbid, and tranſparency did not enſue on adding a further quantity of this acid.

(*b*) Muriated barytes produced a conſiderable turbidneſs, which was not removed by adding concentrated acetous acid.

(*c*) Nitrated ſilver induced a ſlight turbid appearance.

(*d*) Mild alkalies induced no viſible change.

(*e*) Pruſſianated

(*e*) Pruſſianated foſſil alkali occaſioned a very ſlight opal coloured appearance, and after ſtanding ſix days a very ſmall quantity of whitiſh ſediment was thrown down, which diſſolved on concentrated acetous acid being added, and the liquid turned greeniſh; but, after ſtanding, a little greeniſh ſediment was depoſited, not, however, apparently more than was produced by a mixture of this Pruſſian alkali, acetous acid, and water.

(*f*) Phoſphorated foſſil alkali produced no turbidneſs or precipitation on ſtanding a week; but on the addition of $\frac{1}{100}$ gr. of nitrated mercury (which had been made by fully ſaturating the nitrous acid with mercury) the mixture grew inſtantly thick, and depoſited a copious white ſediment.

3dly, The remainder of the reſiduum, in the retort above mentioned to have been left after diſtilling to dryneſs acetous acid in which JAMES'S Powder had been boiled, did not totally diſſolve in a large proportion of nitrous acid diluted; but was wholly taken up on adding a little marine acid. A great part of the ſuperabundant acid of this ſolution being carried off by evaporation, it was examined with the following ſubſtances.

(*a*) Adding a little of it to a large proportion of water, milkineſs enſued.

(*b*) The ſame appearance took place with a large proportion of lime-water.

(*c*) A turbid bluiſh colour was produced on adding Pruſſian mineral alkali, and on ſtanding a bluiſh ſediment took place.

(*d*) A poliſhed copper plate was not at all whitened by immerſion in this ſolution; but, on adding to it $\frac{1}{100}$ of a grain of nitre of mercury, the copper was rendered paler coloured.

The deficiency of twenty grains of powder in theſe experiments with acetous acid muſt be aſcribed partly to the

ſolution

ſolution in this menſtruum, and ſtill more to the waſte in the paper filter, and to its adhering to the retort when firſt boiled.

Theſe experiments indicated the ſame kind of ſubſtances as the experiments with water, namely, calcareous earth in a combined ſtate; phoſphoric acid; calx of antimony and of iron. It appears alſo, that JAMES's Powder is either wholly or partially ſoluble in about 300 times its weight of concentrated acetous acid.

III. *With nitrous acid.*

The 240 grains of powder remaining after the experiments with acetous acid, p. 11. were digeſted in the cold twelve hours, in three ounce meaſures and a half of purified and concentrated nitrous acid, diluted with four ounces of pure water, and then diſtilled with a gentle heat till there remained about two ounce meaſures. After ſtanding twenty-four hours, about one ounce and a half of clear liquid, which was very corroſive and acid, was drawn off by means of a ſyphon. The turbid liquid and cloſe white ſediment remaining, being mixed with one ounce of diſtilled water, were poured upon a filter of paper, and hot diſtilled water was repeatedly poured upon this filter till it paſſed through almoſt taſteleſs. The firſt portions of the filtered liquid, in quantity ten ounces, being mixed together, were ſet to evaporate in a glaſs pan. As ſoon as the liquor grew hot, the turbidneſs diſappeared; and as the evaporation went on, firſt clouds, and afterwards portions of ſediment, appeared in a clear liquid. The evaporation being continued nearly to dryneſs, a white, porous, or cellular cake was left, that weighed 129 grains. The liquid obtained

by diſtillation from the ſolution which left this maſs was found to be merely diluted nitrous acid.

The reſiduum left on the filter which had reſiſted ſolution in nitrous acid, being well dried, weighed a little more than 142 grains. This reſiduum was digeſted, and boiled as before in nitrous acid; and this menſtruum, diſtilled from the reſiduum, being evaporated to dryneſs, afforded 6,5 grains of a whitiſh maſs. The reſiduum left on the filter after this ſecond application of nitrous acid, being well dried, weighed 132 grains.

The maſs of 129 grains, left on evaporation of the above ſolution of JAMES's Powder in nitrous acid, in a few hours began to deliqueſce, eſpecially at the edges. Some of the deliqueſcing part of the maſs was diſſolved in one ounce and a half of water, forming an opal-coloured ſolution, with a white ſediment. This opal-coloured ſolution being filtered was examined.

(*a*) It rendered lime-water milky; and the milkineſs did not diſappear on adding concentrated acetous acid, but readily on pouring into the mixture a little acid of nitre.

(*b*) It turned thick and white, and ſoon depoſited a copious ſediment of white matter, with a few drops of nitrous ſolution of mercury; and became turbid alſo with nitrated ſilver.

(*c*) With muriated barytes it became very turbid, and remained ſo after adding acetous acid; but grew clear again on adding nitrous acid.

(*d*) Acid of ſugar produced a turbid appearance.

(*e*) Cauſtic volatile alkali produced very little precipitation; but a copious one took place with mild alkali of tartar; which precipitated matter, after decanting the clear ſolution, was nearly all diſſolved by acetous acid, and the remainder was readily taken up by the marine as well as by the nitrous acid.

(*f*) Pruſſian

(*f*) Pruſſian alkali occaſioned a light blue colour, but no turbid appearance till the mixture had ſtood ſeveral days, which was then ſlight.

(*g*) No change of colour was produced on a copper plate.

A little of the ſoft and deliqueſcing part, juſt mentioned to have taken place at the edges of the ſolid maſs, taſted bitter and ſour. It melted under the blow-pipe into a horny kind of globule; but the dry part of this maſs could not be fuſed by this means.

This ounce and a half of ſolution being conſumed in theſe trials, the ſame quantity of boiling diſtilled water was poured on the precipitate or part not diſſolved by this quantity of water on the firſt affuſion. After ſtanding and boiling, the precipitate appeared to be but little diminiſhed. The clear liquid did not as before render lime-water turbid; but a precipitate enſued with nitrated mercury, which on compariſon was found to be a more delicate teſt of phoſphoric acid than lime-water. This ſolution alſo, by this ſecond affuſion of water, did not as before grow thick with mild alkali of tartar, nor blue with Pruſſian alkali. The ſediment, undiſſolved by theſe two applications of water, did not totally diſſolve in a ſuperabundant quantity of nitrous acid; but completely and immediately in a ſmaller quantity of marine acid; and this ſolution in marine acid, with a large proportion of water, produced milkineſs; with Pruſſian alkali, it turned of a deep blue colour; it did not whiten copper; ſaccharine acid and ſalited barytes only ſlightly diſturbed its tranſparency.

By theſe experiments I found the ſolution of JAMES's Powder in nitrous acid contained, probably, a pretty conſiderable proportion of calcareous earth united to both nitrous

and phoſphoric acid; a little phoſphoric acid in a free ſtate; and a ſmall proportion of calx of antimony and of iron.

Ninety grains of the dry part of the above maſs of 129 grains, p. 13. were repeatedly triturated and digeſted in alcohol till almoſt nothing was taken up by it. This ſolution, being filtered, was evaporated to dryneſs, and afforded 20 grains and a half of a fine white ſalt, very bitter, which, on expoſure to the air, ſoon became liquid, but very turbid.

The powder that had thus ceaſed to yield any thing further to alcohol was repeatedly triturated and boiled in pure water, till the liquid paſſed taſteleſs through the filter; and the filtered liquors, being evaporated, left eight grains more of a leſs bitter and leſs deliqueſcent ſubſtance than that from alcohol. Part only of theſe eight grains was ſoluble readily in water; and they appeared to be a mixture of the ſaline matter diſſolved in alcohol, and of the inſoluble reſiduum in that menſtruum.

The powder remaining on the filter after theſe ſolutions in alcohol and water being dried, weighed nearly 59 grains. It was white and taſteleſs.

I next examined theſe products more particularly; and *firſt* the twenty grains and a half which had been diſſolved in alcohol.

(*a*) With a large proportion of water it produced a rather turbid appearance, and, after ſtanding, a ſediment of calcareous earth was depoſited.

(*b*) This laſt ſolution (*a*) being filtered, with mild alkalies grew very thick, and depoſited a ſediment that was readily taken up by acetous acid.

(*c*) With cauſtic volatile alkali its tranſparency was ſcarcely diſturbed.

(*d*) With acid of ſugar it became thick and white; and

(*e*) White

(*e*) White as cream of milk with phoſphorated mineral alkali; the ſediment from which mixture did not diſſolve in a quantity of boiling water that would have diſſolved vitriolated lime, nor in vinegar, but was readily taken up by nitrous acid.

(*f*) The tranſparency of nitrated and muriated barytes was ſcarcely diſturbed.

(*g*) It turned infuſion of turnſole red.

(*h*) A little of the deliqueſcent ſalt above mentioned, that had been diſſolved in alcohol, being made nearly dry, on adding to it a mixture of alcohol and acid of vitriol, vapours of nitrous ether were detached with ebullition

(*i*) With lime-water it produced a ſlight ſediment.

(*k*) With Pruſſian alkali at firſt a pale green colour, and afterwards a blue colour was produced; but without any precipitation on ſtanding.

(*l*) This ſubſtance, which had been diſſolved in alcohol, was infuſible under the blow-pipe; and after being heated red-hot on charcoal it was no longer ſoluble in water. Being further examined, it was found to be merely calcareous earth.

This ſoluble part then in alcohol appeared to be nothing but nitrated lime, with ſome traces of calcined iron.

Secondly, The 59 grains of powder, not ſoluble in alcohol, were examined.

(*a*) A mixture of vitriolic acid and alcohol detached from this powder no nitrous ether, nor any vapour that formed white clouds with volatile alkali.

(*b*) It did not effervеſce, and required above 200 times its weight of concentrated acetous acid to diſſolve it.

(*c*) Under the blow-pipe it emitted no ſmell or fume, and with great difficulty melted imperfectly, affording an irregular figured, horn-like, opaque maſs.

(*d*) It

(*d*) It was not diminiſhed or altered in its properties by boiling in lixivium of alkali of tartar.

(*e*) Nitrous acid formed with it, without efferveſcence, a very ſlightly turbid ſolution; which ſolution produced the ſame appearances as thoſe related, p. 14, 15.

(*f*) 50 grains of this powder were diſſolved in nitrous acid, and a great part of the redundant acid being carried off by evaporation, to one half of this ſolution was added lime-water till it ceaſed to produce any milkineſs, and the mixture taſted of lime-water. After ſtanding excluded from the air, the ſediment depoſited from a clear liquid was collected, and being dried it weighed 26,3 grains. This precipitate had the properties of phoſphorated lime, with that proportion of lime and phoſphoric acid which forms a compound ſcarcely fuſible. The liquid in which this precipitate fell ſeemed to contain a little phoſphorated lime, but principally calcareous earth.

(*g*) To the other half of this ſolution in nitrous acid (*f*) was added vitriolic acid, drop by drop, till it no longer diſturbed its tranſparency. After ſtanding, the clear liquid was decanted from the precipitated matter which had taken place, and the precipitate with a ſmall quantity of water was thrown upon a filter. The filtered and decanted liquids mixed together were boiled till the ſmell of nitrous acid ceaſed, and there remained about half an ounce of acid liquor, which being filtered to ſeparate the vitriolated lime precipitated during evaporation, foſſil alkali was added to perfectly ſaturate it. During this union there was an efferveſcence and a ſeparation of more vitriolated lime, which being removed, the ſaturated liquor, by cryſtallization, afforded nearly 26 grains of cryſtals of phoſphorated foſſil alkali, beſides

ſides a little cubic nitre, vitriolated foſſil alkali and iron, with ſome veſtiges of calx of antimony, and phoſphorated lime.

The precipitate thrown down on adding vitriolic acid, and left upon the filter, weighed when dried 26,1 grains, and was vitriolated lime, with a minute portion of calcined antimony and iron.

The 6,5 grains, p. 14. left on evaporation to dryneſs of the ſecond ſolution in nitrous acid, conſiſted of nearly three grains of calcined antimony, and the reſt phoſphorated lime, with a little iron.

1. It appears from the above experiments with nitrous acid, that this menſtruum, by two affuſions, in a large proportion, aided by trituration, digeſtion, and heat, diſſolved $\frac{108}{240}$ of JAMES's Powder that had been expoſed to the action of water and acetous acid; but from the ſmallneſs of the quantity contained in the nitrous acid the ſecond time it was applied, and from its being principally calcined antimony, not more than two of the ſix grains afforded by this ſolution, perhaps, ſhould be conſidered to be *diſſolved*, for the reſt may be ſuppoſed to be merely *ſuſpended*.

The firſt ſolution alſo in this menſtruum was not filtered, and the acid was conſiderably redundant, and there was found in it ſeveral grains of calcined antimony. The real quantity *diſſolved* might therefore probably be eight grains leſs than the above 108 ſtated. According to this mode of calculation, the proportion of the ſoluble part of JAMES's Powder in nitrous acid is $\frac{100}{240}$, or about $\frac{4}{10}$.

2. The whole of this ſoluble part, except a little calx of antimony, is, deciſively, phoſphoric acid and calcareous earth: which

which two ſubſtances may reaſonably be ſuppoſed, from theſe experiments, to have been united together, and to have been in the ſtate of phoſphorated lime in this powder. Conſequently, the proportion of this phoſphorated lime, conſidered as the ſoluble part of JAMES's powder in theſe experiments with nitrous acid, appears to be 40 *per cent.* making a deduction of 1 *per cent.* for the antimonial calx contained in the nitrous acid in the above experiments. It is however already obvious to ſuſpect, that the powder which reſiſted ſolution in this menſtruum may contain more phoſphorated lime; and this conſideration prevents me aſſigning at preſent the above 40 *per cent.* as the whole quantity of it in JAMES's Powder. It cannot however, I think, be a ſmaller proportion.

I do not reckon the calx of iron in theſe calculations, becauſe it is in too ſmall a quantity, and is apparently only to to be looked upon as an accidental extraneous ſubſtance. I ſuppoſe too, that the water and acetous acid applied to the JAMES's Powder uſed in theſe experiments, carried off a proportion of its ingredients equal to that in the remaining powder.

IV. *With marine acid.*

The 132 grains of heavy, white, taſteleſs powder, the reſiduum after boiling 240 grains of JAMES's Powder in nitrous acid, till it had diſſolved that part for which it has any conſiderable affinity, p. 14. were digeſted for twenty-four hours in eight ounce-meaſures of marine acid, the ſpecific gravity of which was 1,170, and diluted with half its bulk of diſtilled water. This mixture was diſtilled in a gentle

gentle heat till there remained about two ounce-meaſures of a very turbid liquor. After ſtanding in a jar two days, it depoſited a cloſe white ſediment, obviouſly much leſs in bulk than the powder added to this menſtruum; and nearly one ounce meaſure and three quarters of clear yellow liquid were drawn off, by means of a ſiphon, which was marked N° 1.

The diſtilled liquid, which was merely diluted marine acid, was poured back on the ſediment and remaining liquid; and after digeſtion twenty-four hours, this mixture was diſtilled as before, till there remained about one and a half ounce-meaſure; but after ſtanding in a jar ſeveral days, the quantity of ſediment depoſited was apparently as great as before the ſecond application of this menſtruum. The clear liquor was drawn off as before, and marked N° 2. The diſtilled liquor being found to be merely diluted marine acid, was poured on the remaining liquid and ſediment a third time; and, after digeſtion, the diſtillation was repeated as before. The remaining liquid having ſtood upon the ſediment ſome time, one ounce-meaſure of clear liquor was drawn off, and marked N° 3. The ſediment did not appear diminiſhed by this third diſtillation; but, as the decanted liquid, N° 3. was found to contain a ſmall quantity of ſome ſubſtance diſſolved or ſuſpended in it, the marine acid diſtilled in this experiment was poured a fourth time on this reſiduum, and after digeſtion boiled. Having ſtood ſeveral days, the clear liquor was decanted, and marked N° 4. To the reſiduum, after theſe four affuſions of marine acid, one ounce of boiling diſtilled water was added, and this mixture was poured on a filter. The powder upon the filter being well dried, was found to weigh 60,1 grains.

In the ounce of boiling water that had been filtered from this reſiduum, I could find nothing but ſome minute particles of that ſubſtance and veſtiges of iron. Two or three drops of the liquor, N° 1. added to three ounces of diſtilled water, produced a pretty conſiderable milkineſs; and, on ſtanding, a cloſe white ſediment was depoſited. Two or three drops of the liquor, N° 2. produced leſs milkineſs and ſediment in the quantity of water juſt mentioned than N° 1. N° 3. ſcarcely diminiſhed the tranſparency of diſtilled water; and N° 4. did not affect it all. The liquids, N° 3. and 4. were diſtilled till there remained about two drachm-meaſures of clear brown liquid, with a cloudy ſediment. N° 3. being poured into two ounces of diſtilled water ſcarcely made it milky; and N° 4. did not diminiſh the tranſparency of water at all. On evaporating to dryneſs theſe mixtures of the liquors, N° 3. and 4. with diſtilled water; that with N° 3. left a yellowiſh dry ſediment which weighed 3,1 grains; and that of N° 4. left 2,2 grains of ſediment. Nothing but calx of antimony could be diſcovered in theſe ſediments. They were reducible readily with tartar; ſcarcely fuſible in the ſpoon; but with phoſphoric acid eaſily melted into an opaque yellowiſh globule.

The liquor, marked N° 1. being poured into twenty-four ounces of diſtilled water produced a very milky appearance; and the ſame appearance, but in a much leſs degree, enſued on pouring the liquor N° 2. into this quantity of pure water. After ſtanding ſeveral days, a white ſediment being depoſited from a clear watery fluid, the clear liquid was drawn off by means of a ſiphon, and the ſediments being dried, that of N° 1. weighed 51 grains; that of N° 2. weighed 6,15 grains; and both were found to be purely Algaroth powder. The water, *viz.* 48 ounces, in which theſe precipitates fell, being evaporated

evaporated to dryneſs, left a little more than four grains of an infuſible kind of ſediment, which was calx of antimony, like that of N° 3. and 4. with a minute portion of Algaroth powder and iron.

The 60,1 grains, p. 21. which reſiſted ſolution in marine acid, were a lighter powder than JAMES's Powder itſelf, rather gritty, quite taſteleſs. This powder was digeſted in one-ounce meaſure of concentrated nitrous acid mixed with two of acid of ſalt for a week; and then this mixture was diluted with four ounces of diſtilled water, and gently boiled till it was reduced to about two ounce-meaſures. On cooling and ſtanding ſeveral days, a ſediment of the ſame kind apparently, and in the ſame quantity as before evaporation, was depoſited, and, after ſtanding, a clear yellow liquid was drawn off. The ſediment, well dried, weighed 55 grains. The decanted liquor being reduced by evaporation from one and a half ounce to about two drachm-meaſures, a ſediment, while hot, appeared, which was calx of antimony, with a minute portion of earthy matter that had ſome properties of phoſphorated lime and calx of iron. A little of the clear liquor on this ſediment being dropped into water produced no milkineſs, nor ſediment, after ſtanding; but the whole of this clear liquor, with ſediment, being evaporated to dryneſs, afforded four grains of the ſame kind of infuſible calx of antimony, mentioned to have been obtained from the acid liquors, N° 3. and 4. above mentioned.

It appears then, that by repeatedly digeſting and boiling in marine acid, and in *aqua regia*, that part of JAMES's Powder which reſiſted ſolution in nitrous acid, which was $\frac{132}{200}$, p. 19. 77 grains were carried off by theſe menſtrua; but conſidering the ſmall proportion contained in theſe acids after the two firſt

affuſions, which afforded 57,15 grains, p. 22., and ſuppoſing the calx to be neither increaſed nor diminiſhed in weight by the acids, the real quantity of ſoluble and fuſible calx of antimony may be ſtated to be that of Algaroth powder; for the other kind of antimonial calx obtained by ſubſequent affuſions was probably only *ſuſpended*. Conſequently 240 grains of JAMES's Powder afforded, by the above experiments with marine acid, 57,15 grains of Algaroth powder, and 19,85 grains of a leſs ſoluble and more difficultly fuſible calx of antimony, with a ſmall proportion of phoſphorated lime. The reſiduum, amounting to 55 grains, was of courſe next examined.

Experiments upon the part of JAMES's *Powder which was inſoluble in the above menſtrua.*

(*a*) A few grains of this inſoluble ſubſtance could neither be melted nor carried off in vapour by means of the flame of a candle applied to it upon charcoal, and alſo in the ſpoon, with the blow-pipe; but,

(*b*) Mixed with an equal weight of tartar, it melted on charcoal; and, while in fuſion, ſmall, apparently, metallic grains were diſtinctly perceived; and on cooling they could be ſeen, even without a lens, adhering to an irregularly figured, opaque, whitiſh maſs. Sometimes ſlight exploſions were heard while the flame was applied. The metallic grains appeared more diſtinctly when this powder was mixed with one-third of its weight of powdered calcined bone, than in JAMES's Powder.

(*c*) Ten grains of this powder were melted as above mentioned, by repeatedly applying flame with the blow-pipe to

two

two or three grains of it at a time mixed with tartar. The opaque whitiſh maſſes, with metallic grains in them, thus obtained, being pulverized, were digeſted and gently boiled in diluted nitrous acid. The filtered ſolution afforded nitre, and nitrous acid in a free ſtate, the greateſt part of which ſuperabundant acid being carried off, the lixivium did not whiten copper, or throw down any calx but iron with Pruſſian alkali. The reſiduum that reſiſted ſolution in nitrous acid was digeſted and gently boiled in *aqua regia.* On ſtanding it was decanted, and this decanted liquid being heated, to carry off ſuperabundant acid and water, it afforded on mixture with water 1,2 grain of Algaroth powder, and no metallic matter could be detected in the water excepting a little iron. A ſmall part only being diſſolved by the *aqua regia*, the reſiduum was expoſed to the flame of a candle with tartar as before; and, by the aid of a lens, I could juſt perceive two or three metallic grains in the fuſed maſs. To this maſs the *aqua regia* was again applied, and 0,15 grain of Algaroth powder was obtained, and no other metallic calx was found but iron. A third affuſion of *aqua regia* indicated an exceedingly minute portion of Algaroth powder; but I could afterwards perceive no more metallic grains in the reſiduum expoſed to flame with tartar, nor obtain more Algaroth powder from the ſolution of the fuſed maſs in *aqua regia.* The reſiduum that reſiſted ſolution melted readily with a little phoſphoric acid into an opaque, ſomewhat yellowiſh, white globule, not unlike calcined bone fuſed with phoſphoric acid, and a minute portion of flowers of antimony. The quantity, however, of this reſiduum was ſo ſmall, that I deſpaired of determining its nature further by more experiments.

Having

Having found that this inſoluble powder would not melt with ſulphur when heated *red-hot*, I made the following experiment.

(*d*) Twenty grains of it being mixed with three times its weight of ſulphur, were put into one of Mr. WEDGWOOD's crucibles that would contain one ounce-meaſure, which, with a cover well luted on, was put into a three-inch Engliſh crucible, and calcined bone in powder filled the ſpace between the two crucibles. After expoſing this charge to a red heat half an hour, and in a white heat ten minutes, the crucibles were cooled; and being opened, the pyrometer piece of WEDGWOOD in the bone aſhes was found to indicate 65°, and the mixture in the inner crucible had apparently been melted into a reſin-like maſs that adhered firmly to the ſides of the veſſel. Twenty-eight grains were ſcraped off, which, after digeſtion and boiling in marine acid, afforded ſix grains of Algaroth powder. A great deal of hepatic air was diſcharged during this ſolution, and very little ſulphur was left on the filter with the part not diſſolved by the marine acid. This undiſſolved part, which weighed ſix grains, was blackiſh, taſteleſs, not heavy. It was infuſible with the blow-pipe, both alone, and mixed with ſulphur and tartar; but with phoſphoric acid it melted into a blackiſh ſcoria-like maſs. I could only conjecture, that this laſt part was antimonial calx, ſo far vitrified with phoſphorated lime as to be neither ſoluble nor reducible or fuſible, except with phoſphoric acid.

(*e*) By a ſimilar experiment, but with alkali of tartar twenty grains, ſulphur thirty grains, and ten grains of this inſoluble part of JAMES's Powder, a fuſed maſs was obtained that partially diſſolved in water, and afforded kermes mineral on pouring an acid into this ſolution; but a great part was inſoluble

inſoluble in water and acids, and ſeemed to be of the ſame nature as the ſix grains of reſiduum juſt mentioned (*d*).

I could only conclude from theſe experiments on this inſoluble matter, that it contained calx of antimony; but as to the proportion of it, and the other ſubſtance with which it is joined, I conjecture that it may be about half the quantity of the inſoluble powder; and that the other half is antimonial calx and phoſphorated lime, ſo highly calcined and vitrified together as to reſiſt ſolution in acid menſtrua, decompoſition by charcoal, and fuſion with fixed alkalies, but not by phoſphoric acid.

I ſhould not have been ſatisfied with here terminating this analyſis without enquiring further into the nature of this inſoluble matter; but I diſcontinued this analytic inveſtigation in order to derive light from the ſynthetic experiments which will be related hereafter.

Theſe laſt experiments ſeem to ſhew, that the proportion of antimonial calx is not ſo great as might have been aſſigned from the experiments with nitrous acid, marine acid, and *aqua regia*.

The ſubſtances and proportions of them, obtained from 240 grains of JAMES's Powder, by the above experiments, are as follow:

	Grains.
Phoſphorated lime, with a little antimonial calx,	100,
Algaroth powder, ...	57,15
Inſoluble antimonial calx, with a little phoſphorated lime, ...	19,85
The ſame inſoluble calx, with, probably, a little phoſphorated lime, ...	55,
Waſte, ...	8,
	240,0

As

As it may be objected, that concluſions drawn concerning the nature of calces might be erroneous if nitrous acid had been applied previouſly to ſubſtances containing them, I made the following experiment.

Experiment with marine acid applied to JAMES's *Powder, which had not been expoſed to the action of nitrous acid, or any other menſtruum.*

50 grains of JAMES's powder were digeſted, and gently boiled in two ounce-meaſures and a half of concentrated marine acid diluted with one ounce of diſtilled water till there remained only about one ounce-meaſure. A great part of the powder appeared to be evidently diſſolved. On cooling, cryſtals of muriated antimony were formed upon a white ſediment. The clear liquid with the cryſtals being decanted, the ſediment was boiled twice, as before, with marine acid; but the ſecond affuſion of this menſtruum brought off but eight grains of this powder, and the third only four grains. The remaining ſediment, being well dried, weighed 14 grains. Now it has been ſhewn already, that the nitrous and marine acids, ſucceſſively applied, diſſolved $\frac{177}{240}$, or all but about 60 grains; and in the preſent experiment, the marine acid diſſolved $\frac{36}{50}$, which is in the proportion of $\frac{180}{250}$, or nearly $\frac{173}{240}$; ſo that, on account of the trifling difference in theſe proportions, it may, perhaps, be fairly concluded, that the properties of the calx in JAMES's Powder are not altered by nitrous acid to affect its ſolubility in marine acid. And further, this inſoluble powder in the preſent experiment was found to have the ſame properties as that in the former experiments.

To

To know whether JAMES's Powder contained any ſubſtance that could be decompoſed by mild fixed alkalies, the following experiments were made.

Theſe experiments with fixed alkali ſeemed to be eſpecially neceſſary, becauſe phoſphoric acid, lime, and antimonial calx, are ingredients in JAMES's Powder; and it was obvious to ſuſpect, that this acid might be united with calx of antimony as well as with lime; which phoſphorated antimony would be decompoſed by alkalies, and yield phoſphorated alkali.

Experiments with fixed alkalies.

100 grains of JAMES's Powder were boiled in ſix ounces of water, with 50 grains of mild alkali of tartar, for three hours, and then the remaining liquid was filtered, and evaporated to dryneſs; but the matter left after evaporation was nothing but the alkali uſed in the experiment, with a little of the powder itſelf.

The reſult was the ſame on making the experiment with cryſtallized mineral alkali inſtead of alkali of tartar.

Synthetic Experiments.

ALTHOUGH the inability to prepare JAMES's Powder would not prove the above concluſions, with reſpect to its compoſition, to be erroneous; the being able to compoſe a ſubſtance

poſſeſſing all the ſame properties as JAMES's Powder, by uniting or mixing together the ſubſtances ſhewn by the above analyſis to enter into its compoſition, would afford all the proof and demonſtration which can be had in the ſcience of chemiſtry.

The above analyſis ſhewed no eſſential ingredients of JAMES's Powder but antimonial calces, phoſphoric acid, and calcareous earth, which two laſt ſubſtances appeared to be united together; but it would have been vain and unneceſſary labour to have attempted to make this powder by mixtures of any of the commonly known calces of antimony and phoſphorated lime; becauſe none of them, from their well known qualities, could form a powder of the ſame colour and ſpecific gravity as JAMES's Powder, and like it partially ſoluble in acids. From the above experiments, however, the probability was evident, that this ſubſtance might be made by calcining together antimony and bone-aſhes; which operation produces a powder called LILE's and SCHAWANBERG's fever-powder; a preparation deſcribed by SCHRODER and other chemiſts 150 years ago. The receipts for this preparation differed in the proportion of the antimony to the bone aſhes, and in the ſtate of the bone; ſome directing bone ſhavings to be previouſly boiled in water; others ordered them to be burnt to aſhes before calcining them with antimony; and in other preſcriptions the bone ſhavings were directed to be burnt with the antimony. According to the receipt in the poſſeſſion of Mr. BROMFIELD, by which this powder was prepared forty-five years ago, and before any medicine was known by the name of JAMES's Powder, two pounds of hart's horn ſhavings muſt be boiled to diſſolve all the mucilage, and then, being dried, be calcined with one pound of crude antimony, till the ſmell of

ſulphur

ſulphur ceaſes, and a light grey powder is produced. The ſame preſcription was given to Mr. WILLIS, above forty years ago, by Dr. JOHN EATON, of the College of Phyſicians, with the material addition, however, of ordering the calcined mixture to be expoſed to a great heat in a cloſe veſſel to render it *white*. Mr. TURNER made this powder above thirty years ago by calcining together equal weights of burnt hart's horn and antimony in an open veſſel, till all the ſulphur was driven off, and the mixture was of a light grey colour. He likewiſe was acquainted with the fact, that by a ſufficient degree of fire in a cloſe veſſel this cineritious powder turned *white* *. Mr. TURNER alſo prepared this powder with a pound and a half of hart's horn ſhavings and a pound of antimony, as well as with ſmaller proportions of bone. SCHRODER preſcribes equal weights of antimony and calcined hart's horn; and POTERIUS and MICHAELIS, as quoted by FREDERIC HOFFMAN, merely order the calcination of theſe two ſubſtances together (aſſigning no proportion), in a reverberatory fire for ſeveral days. In the London *Pharmacopœia* of 1788, this powder is called *Pulvis antimonialis*; and it is directed to be prepared by calcining together equal weights of hart's horn ſhavings and antimony.

Powders made from various proportions of antimony and bone-aſhes, after ſolution in nitrous acid, left a reſiduum of antimonial calx much leſs or greater in quantity than JAMES's Powder did by the ſame menſtruum, except two of Mr. TUR-

* It is probable, that this powder was made for ſeveral years with merely the heat neceſſary to carry off the ſulphur and calcine the bone, in an open veſſel over a charcoal fire in a common grate, and conſequently it was of a light clay or aſh colour. In this manner, Mr. BROMFIELD told me, he prepared SCHAWANBERG's Powder 46 or 47 years ago. Its property of turning *white* in a greater degree of fire appears to have been a ſubſequent diſcovery.

NER's proportions, *viz.* two parts of antimony and one of calcined bone, and equal weights of bone ſhavings and antimony. The quantity of this calx was, however, greater in the powder from the former of theſe two laſt proportions than the latter of them; which latter correſponded ſometimes exactly, and always nearly, with the weight of the calx from a given weight of JAMES's Powder. This calx afforded alſo the ſame proportion of Algaroth powder as the calx in JAMES's Powder; and the inſoluble part of the calx afforded metallic grains like thoſe from the inſoluble part of the calx in that powder.

I found then an exact correſpondence between what I conſider to be the eſſential and peculiar properties of JAMES's Powder, and the properties of a powder made by uniting or mixing together the ingredients of JAMES's Powder found by analyſis. But, in order to ſhew the identity or difference of the qualities of theſe two ſubſtances, I made comparative obſervations on them, and repeated the above analytic experiments on JAMES's Powder with the preparation made by calcining together equal weights of bone ſhavings and antimony, in an open veſſel, to carry off the ſulphur, and then in cloſe veſſels applying ſuch a degree of fire as to render them *white*, that is, on the ſame preparation as the *Pulvis antimonialis* of the London *Pharmacopœia*.

Firſt, I compared, more particularly, the ſenſible qualities of ſeveral different ſpecimens of JAMES's Powder with various parcels of the *Pulvis antimonialis* made by different chemiſts. All of theſe would be called white powders, but not two of them were ſo in the ſame degree. Moſt of the papers of the *Pulvis antimonialis* were whiter than thoſe of JAMES's Powder; but others were of a very light ſtone colour, and ſome had a ſhade of yellow, ſo as to reſemble very exactly JAMES's Powder; but

but all the parcels of JAMES's Powder had either a ſhade of yellow or of ſtone colour, and none were perfectly white, or ſo white as ſome ſpecimens of the *Pulvis antimonialis.* Some of the parcels of JAMES's Powder and of the *Pulvis antimonialis* taſted braſſy; and other ſpecimens of both powders had no taſte. All of theſe powders were gritty. Moſt of the parcels of the *Pulvis antimonialis* were a little ſpecifically heavier than thoſe of JAMES's Powder. The ſpecific gravity of both powders was increaſed by expoſing them to ſuch a degree of fire as brought them into almoſt a ſemi-vitrified ſtate; and, on the contrary, the ſpecific gravity of the *Pulvis antimonialis* was leſs than it is in its uſual ſtate, when made in ſuch a degree of fire that the mixture preſerves the powdery form.

The experiments with water on the *Pulvis antimonialis* produced the ſame kind of appearances, but more ſlightly than thoſe with JAMES's Powder; for the hot ſolution of the former grew leſs milky on cooling than that of the latter, and on evaporation to dryneſs leſs ſediment was found of the ſolution of *Pulvis antimonialis* than after that of JAMES's Powder *.

The experiments with acetous acid on the *Pulvis antimonialis* ſhewed, that this menſtruum diſſolved ſometimes a greater, and ſometimes a ſmaller proportion of it than of JAMES's powder; and the diſſolved matter was found to be antimonial calx, phoſphorated lime, and calx of iron, and no other ſubſtance.

It has been already ſaid, that the proportion of ſoluble matter in nitrous acid was the ſame, or nearly ſo, of the *Pulvis antimonialis* as that of JAMES's Powder; and this diſſolved matter was phoſphoric acid, calcareous earth, with a little antimonial calx, and a minute portion of calx of iron, as exactly

* The reaſon for this difference is aſſigned in another place.

as could be expected from the nature of the ſubſtances and the experiments, in the ſame proportion as thoſe in JAMES's Powder.

The Algaroth powder, obtained by means of ſolution of the *Pulvis antimonialis* in marine acid, was in the ſame proportion as nearly as could reaſonably be expected from the nature of the experiments as that obtained from JAMES's Powder. And the part that reſiſted ſolution in this menſtruum was partially reducible to a metallic form, and had otherwiſe the ſame properties, as far as diſcovered, as the inſoluble part of JAMES's Powder.

Having now formed a powder poſſeſſed of properties ſimilar in *kind* to every one of thoſe aſcertained in JAMES's Powder, with ſcarcely any difference in the *degree* of them, if it be thought that among theſe properties are thoſe which are eſſential and peculiar ones of JAMES's Powder, the concluſion that theſe two are the ſame kind of things muſt be admitted to be juſt. The nature of one of the ingredients of JAMES's Powder, *viz.* the irreducible part of the inſoluble matter, p. 342. is not fully elucidated by the ſynthetic experiments; but in ſo far as they ſhew, that this part equally exiſts in the powder formed by calcining together antimony and bone, which is concluded to be JAMES's Powder, the objection againſt the concluſion with reſpect to the identity of the two ſubſtances, on the ground of this inconſiderable part of JAMES's Powder not being well underſtood, muſt be of little weight.

Several reaſons, more intereſting to myſelf than to the Society, induced me to authenticate by additional teſtimonies thoſe analytic experiments, which may be conſidered to be more deciſive than the reſt for eſtabliſhing the identity of JAMES's Powder, and a powder formed by calcining together antimony and bone-aſhes. I therefore requeſted Mr. CAVALLO and Mr. TURNER to be preſent

preſent when I made thoſe experiments on the *Pulvis antimonialis*, prepared by Mr. GRIFFIN, of Apothecaries' Hall, and JAMES's Powder. Having, in the preſence of theſe two Gentlemen*, broken the ſeal of a phial of JAMES's Powder, bought of F. NEWBERY, and taken out of it the quantity required for the experiments, the bottle was again ſealed by Mr. CAVALLO with his ſeal, as well as the phial from which was taken the *Pulvis antimonialis*. Should any experiments be publiſhed, which eſtabliſh different concluſions from thoſe contained in this Paper, with reſpect to the identity of theſe two powders, I ſhall be happy to endeavour to aſcertain the truth by experiments, on the remaining parcels of the two powders, in the preſence of competent judges.

I ſhall next relate the experiments made with the view of confirming or invalidating the concluſions drawn from the above analyſis, with reſpect to the ingredients and proportions of them in JAMES's Powder; and by which I eſpecially endeavoured to make ſuch antimonial calces as this ſubſtance contains, by proceſſes different from thoſe above related.

EXP. I. (*a*) Hart's horn ſhavings, of ſix different parcels, well dried, ſeparately calcined in the ſame manner, and apparently to the ſame degree as when calcined with antimony to make LILE's Powder, afforded a light brown coarſe powder, with a few thin light black pieces, and loſt from 43 to 48 *per cent.* of their weight. The mean loſs of weight, of courſe, was 45½ *per cent.*

(*b*) This calcined bone (*a*), being pulverized, was expoſed to a greater degree of fire, in cloſe veſſels, than that neceſſary to render the calcined mixture of antimony and bone-aſhes *white*. The loſs of weight by this ſecond calcination or expoſure to fire was from two to three *per cent.*; and the aſhes

* Dr. CLARKE alſo was preſent at the beginning of theſe experiments.

were

were as white as ſnow. The total mean loſs of weight, by theſe two calcinations, was then $\frac{48}{100}$.

EXP. II. 2000 grains of coarſely powdered antimony were calcined in an earthen diſh, as in making LILE's Powder, by conſtantly raking them about for above three hours. During a great part of this time the veſſel was red hot at the bottom; and for the laſt hour the ſulphureous fumes had entirely ceaſed. The calx thus produced was of a pale bluiſh colour; it melted, in a low degree of heat, into an opaque, ſcoria-like brittle maſs; it yielded no hepatic air with marine acid; it weighed 1409 grains, or the antimony loſt nearly 29½ *per cent.* The pyrometer in the veſſel with the antimony during its calcination, was contracted to the 6th degree of WEDGWOOD's ſcale.

The ſum therefore of the loſs of antimony and bone by calcination in this manner, ſeparately, was 37½ *per cent.* Theſe two ſubſtances were in the next place calcined together in the ſame manner in an open veſſel, as above mentioned.

EXP. III. 2000 grains of antimony from the ſame parcel as that in the laſt experiment, and an equal weight of hart's horn ſhavings taken from the ſame parcel as thoſe were in Exp. 1. were calcined together in the ſame manner that theſe ſubſtances had been ſeparately. During the firſt quarter of an hour, the mixture ſmoked, was black, ſmelled ſtrongly of ſulphur, and felt ſoft. For half an hour more, the ſmell of ſulphur continued, the mixture turned brown, and the bone was reduced to aſhes. At the end of this time, not only the bottom of the veſſel might be kept red hot without any ſigns of fuſion; but the ſmell of ſulphur, though weakly, continued for half an hour more in a heat to keep a great part of the mixture red hot. At this time the ſulphureous ſmell rather ſuddenly diſappeared, and could not be perceived, though a little

little of the mixture was made quite red hot for a quarter of an hour further; during which no fume was ſeen, or ſmell perceived. After cooling, a light grey or cineritious heavy powder was left; on examining which, argentine *ſpicula* were ſeen in the larger grains of this calcined ſubſtance. It weighed 2200 grains, therefore the loſs of weight was 45 *per cent.* The WEDGWOOD pyrometer pieces indicated 8°. In other ſimilar experiments the loſs, by calcination, was from 37 to 41 *per cent.*; therefore the mean proportion loſt in theſe experiments muſt be ſtated at 41 *per cent.*

It appears, that the calcination of antimony with bone-aſhes is much more ſpeedy than when by itſelf, but the degree of fire was a little greater in the laſt experiment than in that with antimony alone. Conſidering the nature of theſe experiments, perhaps, it may be more reaſonable to impute the $3\frac{1}{2}$ *per cent.* greater loſs in this laſt experiment than the ſum of the loſs in Exp. 1. and 2. to the greater inſenſible ſublimation of the calx from more fire in one caſe than in the other, than to refer it to the larger quantity of air combined with the metal in the former of theſe two laſt experiments.

EXP. IV. The above light clay or aſh-coloured powder, obtained in the laſt experiment by calcining together antimony and bone, being expoſed to various degrees of fire from 20° to 165° of WEDGWOOD's pyrometer, in cloſe crucibles, was not at all increaſed in weight, but generally loſt about 5 *per cent.* when a pretty large quantity, as a pound, was in the veſſel. A part of this loſs muſt be referred to the adheſion or vitrification of the charge with the ſides of the crucible, and part to the deficiency of the bone itſelf, as above ſhewn, by further expoſure to fire. I am ſenſible, that in experiments of this nature all calculation muſt neceſſarily, to a certain degree,

be vague; yet it may be of ſome application to obſerve, that the proportion of antimonial calx, eſtimated to be contained in LILE's Powder or *Pulvis antimonialis*, and JAMES's Powder, p. 343. from the analyſis of them, does not differ more conſiderably from the proportion of this calx than may, perhaps, be reaſonably expected on calculation from theſe four laſt experiments to exiſt in them: for 70½ parts of antimonial calx, p. 352. to 54½ parts of bone-aſhes, p. 351. is as about 56,4 parts of this calx to 43,6 parts of calcined bone; and, on analyſis, JAMES's Powder afforded $\frac{57}{100}$ of antimonial calx, and $\frac{43}{100}$ of phoſphorated lime, or nearly ſo, p. 343. allowing for the waſte.

EXP. V. This experiment ſhews the degree of fire neceſſary to render the antimony calcined with bone of a white colour; and that this whiteneſs does not depend on the air, but on the fire.

(*a*) 1500 grains of the calcined mixture of antimony and bone, Exp. 3. were kept red hot in a cloſe veſſel for half an hour. On cooling, I found the powder changed from a cineritious or clay colour to a whitiſh colour with a ſhade of yellow. The ſides of the crucible were not glazed. The pyrometer in the middle of the powder had contracted to 40°. This powder was much inferior in whiteneſs to JAMES's Powder, being much yellower.

(*b*) Another parcel of the ſame powder, Exp. 3. was expoſed in the ſame manner, but to a greater degree of fire, in which the crucible was almoſt white hot for half an hour. After cooling, the powder was found changed to a looſely cohering, ſnow-white, heavy maſs, and the ſides of the crucible were covered with a yellow glaze. This maſs, which

was

was eaſily detached from the veſſel, was found covered with a yellow vitreous coat over the whole ſurface of it that had been in contact with the crucible. In the white ſolid, on breaking it, many argentine *ſpicula* were ſeen. The pyrometer uſed in all theſe experiments indicated 71°.

(*c*) 1500 grains of the ſame parcel, Exp. 3. were expoſed in an open crucible to the fire of a melting furnace; no fumes aroſe till the crucible began to be almoſt white hot. After inverting another crucible, with a ſmall hole in its bottom, the fumes continued to aſcend at times through the aperture for a quarter of an hour. The crucible was then taken out of the fire, and on cooling a *whitiſh powder* was found, but no glazing, and the pyrometer indicated 28°. On again expoſing this crucible with one inverted over it in the melting furnace, but to a greater degree of fire, ſtill more fumes aroſe; but, on cooling, the charge was ſtill in the ſtate of a powder, though *whiter* than before; and the inſide of the inverted crucible was covered with ſilvery particles, and the hole of it was ſurrounded with argentine *ſpicula*, in a ſtellated form. The pyrometer indicated 39°. On reducing a little of this powder to a greater degree of fineneſs, it was as white as JAMES's Powder, with a yellowiſh caſt like it, but inferior in whiteneſs to a ſpecimen of *Pulvis antimonialis*. This crucible, containing its charge, with a cover cloſely luted on it, was put again into the fire, which was raiſed much higher than before; and, after being expoſed in it twenty minutes, the powder in the crucible became a looſely cohering ſolid, as *white as ſnow*, with a vitreous yellow coat, as before obſerved; the inſide of the crucible was glazed and covered with *ſpicula*. The pyrometer-piece in the middle of the powder was alſo covered with a yellow coat, but not

glazed, and it indicated 81°. This looſely cohering ſolid being pulverized afforded a *whiter* powder than JAMES's Powder.

(*d*) The crucible, with its charge (*b*), having a cover well luted on it, was again put into the furnace, and the fire raiſed to almoſt as great a degree as I was able. This intenſe heat was kept up above an hour. After cooling, a white hard ſolid maſs was found within the crucible. On breaking the veſſel, to detach from it the charge, this ſolid maſs was found as hard as marble, and to have received its figure from the crucible. Its ſurface was covered with a yellow vitreous coat, and the whole inſide of the veſſel had a beautiful gold-coloured glaze with many argentine *ſpicula*. The pyrometer piece in the middle of the charge was alſo covered with a fine yellow glaze, and indicated 166°. This ſolid, hard maſs weighed only 21 grains leſs than before the experiment, though the whole inſide of the crucible was glazed, and had ſhining *ſpicula* upon it. A piece of this hard maſs being pulverized, it afforded a whiter powder than JAMES's powder is in general.

EXP. VI. 2000 grains of coarſely powdered antimony, mixed with 1105 grains of calcined hart's horn in powder, were calcined firſt in an open veſſel, and then expoſed to a great degree of fire in a cloſe veſſel, as in the above experiments with bone-ſhavings, Exp. 3. and 4. The calcination of this mixture in the open veſſel afforded 2550 * grains, of a leſs whitiſh and rather yellowiſh powder, inſtead of a light aſh-colour, as with bone ſhavings, Exp. 3. p. 353.; and by the ſecond, and even

* In another experiment of this kind 2400 grains of antimony and 1500 grains of calcined bone afforded 3450 grains of yellowiſh light-brown powder. In a third trial, 600 grains of antimony and 400 grains of calcined bone gave 850 grains of yellowiſh brown powder.

repeated

repeated expoſure to fire, it never could be made quite ſo white, but ſeemed more inclined to melt than the powder prepared with unburnt bone. In other reſpects the effects of fire were apparently the ſame, or nearly ſo, as in the experiments with bone ſhavings, Exp. 3, 4. ; for though the loſs of weight in this experiment, reckoning that of the antimony at 29½ *per cent.*, and that of the bone aſhes at 2½ *per cent.* ſhould have left 2483 only, inſtead of 2550 ; yet, in other ſimilar experiments, the product correſponded nearer to this calculation, and the loſs was ſometimes leſs both of the antimony and bone calcined ſeparately. Some of the perſons who prepare the *Pulvis antimonialis* ſay, that the whiteſt colour is obtained by firſt boiling the bone ſhavings to diſſolve their mucilage, and then calcining them with antimony as above ſhewn. Mr. LILE's receipt directs previous decoction of the hart's horn.

It will not be difficult, from theſe experiments, to give a probable reaſon for the JAMES's Powder being generally of a yellowiſh caſt, and for different parcels of it, as well as of the *Pulvis antimonialis*, being generally of different degrees of whiteneſs and ſhades of yellow. The colour of this preparation is, however, a very delicate one. I once directed a perſon to calcine together antimony and bone ſhavings, in the uſual manner, to that ſtate in which the white powder may be produced by a due degree of fire ; but, inſtead of a ſnow-white maſs, I could not by any degree of fire obtain any colour but a dirty whitiſh or light ſtone colour ; though repeated calcinations were employed. The reaſon of the failure was, that the earthen diſh had been broken during the calcination, and a few very ſmall pieces of it had ſcaled off, and being mixed with the powder occaſioned this diſappointment with

with reſpect to colour. The ſame diſappointment has been alſo occaſioned by uſing a ruſty iron rod in calcining the mixture.

The bone-aſhes procured from the ſal ammoniac and ſpirit of hart's horn manufactories, frequently failed in producing a white powder; and ſo did ſometimes the bone-aſhes, called prepared hart's horn, ſold by the druggiſts. Even after a fine white coloured maſs had been made, if it was pulverized in an iron mortar that had extremely little calx upon its ſurface, or dirt, the powder was not white.

The yellow coat and glaze on the ſides of the crucible and ſurface of the calcined mixture of bone and antimony, in theſe experiments, is to be aſcribed rather to the fuſion of the clay of the crucible with the antimonial calx, than to the greater degree of fire in the part of the crucible in which it takes place; or than to the calx of iron and ſiliceous earth of the veſſel: becauſe the ſame yellow coat and glazing are produced on the WEDGWOOD pyrometer pieces, which are placed in the middle of the charge, and where the degree of heat cannot be ſo great as nearer the ſide of the crucible, and yet a ſnow-white maſs is produced between theſe clay pieces and the ſides of the crucible. This effect of clay, in forming a yellow coat and glaze, is ſhewn by the obſervation of what happens when the calcined mixture is put into a WEDGWOOD's crucible, which is made of much purer clay than other veſſels of this kind, and when it is ſet in a larger Heſſian crucible with the ſpace betwixt the two veſſels filled with the ſame calcined mixture. After expoſure to a ſufficient degree of fire, *viz.* about 120° of WEDGWOOD's ſcale, the inſide and outſide of the inner crucible will be covered with a yellow vitreous coat and glaze as well as the inſide of the outer crucible in contact with the charge, while the reſt of the matter within theſe veſſels is of a ſnowy

a ſnowy whiteneſs. This yellow coat is one reaſon for the powder being of a ſhade of yellow in ſome ſpecimens.

Suppoſing the fuſibility of the antimonial calces to be diminiſhed the more they are calcined; the following experiment ſhews, that the antimonial calx in JAMES's Powder is more calcined than that in Exp. 2.

EXP. VII. 70½ grains of calcined antimony, as prepared in Exp. 2. triturated with 53½ grains of calcined bone, formed a powder of a bluiſh caſt, which being expoſed in a cloſe crucible, for half an hour, in a melting furnace, the degree of fire in which was 120° of WEDGWOOD's ſcale, it was found melted into a vitreous, pale bluiſh maſs; and the inſide of the crucible was glazed yellow, with red ſtreaks, and had argentine *ſpicula* adhering to it.

EXP. VIII. 800 grains of the calcined antimony of Exp. 2. were calcined for eight hours in a diſh, as in making LILE's Powder, by ſtirring it conſtantly, and keeping the bottom of the veſſel red hot during the whole time; the two laſt hours alſo the whole of the powder was kept red hot. On cooling, this calx was an impalpable light-brown powder.

(*a*) 100 grains of this calx, triturated with an equal quantity of calcined hart's horn, formed a powder very unlike JAMES's Powder, for it was of a light-brown colour. On expoſing it to about 120° of fire it melted into a yellow opaque maſs.

(*b*) The remaining 700 grains of the calcined antimony of this experiment were expoſed to fire and air as before for eight hours longer, and kept red hot a great part of the time; but the calx became very little lighter coloured than before.

(*c*) 100 grains of this calx laſt mentioned (*b*), triturated with as much calcined hart's horn, being expoſed to the degree of fire uſually applied in making the *Pulvis Antimonialis*, in a cloſe

cloſe veſſel, the mixture melted partially into a greyiſh maſs.

(*d*) 150 grains of the calcined antimony (*b*) of this experiment were mixed with an equal weight of calcined hart's horn. This mixture was raked about in an earthen diſh for an hour, during a great part of which time it was red hot. On cooling, the powder was evidently lighter coloured than before this calcination. It was then expoſed in a cloſe crucible to a white heat for half an hour; and, after cooling, a looſely cohering white ſolid, with a vitreous yellow coat, was found, little inferior in whiteneſs, and otherwiſe reſembling JAMES's Powder.

(*e*) 300 grains of the calcined antimony (*b*) of this experiment were raked about in an earthen diſh for an hour, a great part of which time they were kept red hot. On cooling, the calx was found of the ſame colour as before; and after expoſing it in a cloſe crucible in the melting furnace to almoſt a white heat for half an hour, it was obſerved to have been melted into a yellowiſh maſs.

It ſeems at leaſt very probable, from this experiment, that no degree or duration of fire, applied in open or cloſe veſſels to antimony *alone*, can produce a calx of the ſame kind as that in JAMES's Powder: nor, perhaps, can ſuch a powder be compoſed by fire applied, in cloſe veſſels, to calx of antimony mixed with calcined bone; but if antimony duly calcined be mixed with calcined bone, and expoſed to air, in a due degree of fire, for a ſufficient length of time, and then a ſtill greater degree of fire be applied to it in cloſe veſſels, ſuch a compound may be formed as JAMES's Powder. This experiment alſo proves, that the ſulphur in antimony is no ways neceſſary to the formation of this compound.

The

The manner in which air and fire act upon the antimonial calx and phoſphorated lime, I ſhall venture to conjecture.

It is probable, that the calx of antimony and phoſphorated lime combine with each other. 1. Becauſe it requires the application of heat and air for a ſhorter ſpace of time to ſeparate the ſulphur from a given quantity of antimony mixed with bone-aſhes than to produce this effect on antimony *by itſelf:* nor can the ſpeedy calcination of antimony with bone-aſhes be explained by ſuppoſing that the antimony can then bear more heat without melting; for the difference in the degree of heat applied in the two caſes is not, apparently, ſufficient to account for the difference of the times required for deſulphurating the antimony. 2. Becauſe it appears, that heat, applied to antimony in a conſiderable variety of degrees, and air for various ſpaces of time, formed a calx very different in colour, fuſibility, and other chemical qualities, from that produced by calcining this metallic ſubſtance with bone-aſhes. The ſtrongeſt confirmation, perhaps, of the opinion that the antimonial calx and phoſphorated lime are chemically united together is, that, however long the calcination of the antimony and bone-aſhes is continued in the open veſſel it will only produce preciſely the ſame ſubſtance, with reſpect to chemical properties, that is produced the moment the ſulphureous fumes ceaſe.

But why is a ſnow-white powder produced by expoſing a mixture of calcined antimony and bone-aſhes to air and fire for a due length of time, and then applying a greater degree of fire in cloſe veſſels, whereas no ſuch white powder is formed by a mixture of any calx of antimony and bone-aſhes, expoſed to any degree of fire in cloſe veſſels, without previous expoſure to fire and air? The reaſon may be, that in order that the calx ſhould unite with the phoſphorated lime, it muſt be calcined to one

certain degree; which is effected by expoſure to air and fire with the bone-aſhes when it can part or combine with air, ſo as to be reduced to that ſtate in which it will be duly calcined for union with that ſubſtance, which could not happen in cloſe veſſels.

If it be objected, that this explanation does not account for the *whiteneſs* of this preparation, which is only produced by a white heat, and to which air is not neceſſary, the difficulty will be removed by conſidering that this whiteneſs may be induced without any chemical alteration effected by the fire: for, after the firſt calcination in the open veſſel, it ſeems to act, principally, in the ſame way that it does in making grey-coloured bone-aſhes, or imperfectly burnt bone, of a ſnowy whiteneſs, namely, by totally deſtroying matter extraneous to the phoſphoric ſelenite. Fire alſo, in many inſtances, alters the colour of bodies without occaſioning any change in their compoſition; and, perhaps, the change of the light clay or cineritious powder, formed by the calcination of antimony and bone-aſhes in open veſſels, to a ſnowy-white ſubſtance by further expoſure to fire, depends in part upon its increaſe of ſpecific gravity or other mechanical effects of fire. A ſtriking example of the power of fire to change the colour of bodies, by merely increaſing their ſpecific gravity, is afforded by the operation of quartation, in which proceſs, the ſilver being parted, the gold is left of the colour of copper; but, by expoſure to a due degree of fire, it is changed to its well known yellow colour, without undergoing any alteration except an increaſe of ſpecific gravity.

To elucidate the nature of the inſoluble and infuſible part of JAMES's Powder, I made the following experiments, in which I particularly had in view to determine whether ſeveral antimonial calces be wholly ſoluble in acids.

EXP.

EXP. IX. (*a*) Needle-like cryſtals of Algaroth powder diſſolved readily and totally in about thirty times their weight of marine acid.

(*b*) Part of the ſame parcel of cryſtallized Algaroth powder was calcined for above two hours, during which time it was expoſed to as great a heat as it would bear without melting, and during which time it was conſtantly raked about. Nearly half of this calcined calx readily diſſolved in marine acid, and by boiling the remainder in a proportionally much greater quantity of the ſame acid, great part of it was diſſolved, and the ſmall part which ſtill reſiſted ſolution could not be diſſolved in above 100 times its quantity of hot *aqua regia*. This indiſſoluble part afforded regulus with tartar by means of heat applied with the blow-pipe.

(*c*) White flowers of antimony generally left a reſiduum that was either inſoluble, or diſſolved with great difficulty, and in a ſmall proportion, in marine acid or *aqua regia*; yet this reſiduum was reducible. Some parcels of this calx *totally* diſſolved.

(*d*) A little of the antimony, long calcined in a former experiment, and afterwards melted into a yellow maſs, Exp. 8. (*a*), would only partially diſſolve in marine acid and *aqua regia*; but the copious reſiduum it left was reduced.

(*e*) Equal weights of cryſtals of Algaroth powder and calcined bone mixed together, diſſolved *totally* and readily in marine acid. This ſhews, that diſengaged phoſphoric acid does not precipitate antimonial calx when marine acid is preſent.

(*f*) The *calx antimonii nitrata* of the Edinburgh Diſpenſatory, argentine flowers of antimony, hyacinthine glaſs of antimony, and calx precipitated from antimonial tartar by alkali of tartar, all diſſolved readily and *wholly* in marine acid; but,

(*g*) Diaphoretic antimony left a reſiduum which mixed with tartar formed metallic grains under the flame applied by means of the blow-pipe.

(*h*) Any of the above ſoluble antimonial calces by further calcination with air and fire become more difficultly ſoluble, or partly indiſſoluble.

The next experiments were made principally for the purpoſe of knowing whether antimony calcined with vitriolic ſelenite, calcareous earth, and ſiliceous earth, would afford the ſame ſort of calx as antimony calcined with bone-aſhes.

EXP. X. 1500 grains of well burnt and dry plaſter of Paris, mixed with as much pulverized antimony, were calcined together in the ſame manner as the mixture for making LILE's Powder, Exp. 3. In half an hour the ſulphureous fumes diſappeared; after calcining half an hour longer in a heat that kept the bottom of the diſh red hot, the mixture was of a reddiſh brown or copper colour, and after cooling weighed 2520 grains. Suppoſing, therefore, the whole deficiency of weight in this experiment to be from the ſulphur carried off; and ſuppoſing the quantity of air combined with the metal to be the ſame as in Exp. 2. the loſs of weight *viz.* 32 *per cent.* is more than would have been expected; but as in experiments of this nature it is not perhaps poſſible to repeat them under preciſely the ſame circumſtances, the difference of 2½ *per cent.* deficiency more than would have been calculated, may more reaſonably be aſcribed to the ſublimation of antimony than to other cauſes. By expoſure to 70° of fire in a cloſe crucible, this calcined mixture changed to a pale ſtraw-coloured powder, and the ſides of the veſſel were glazed yellow. The change of colour was the ſame in an open veſſel in 60° of fire.

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Though it is probable, from this experiment, that there is an affinity between antimonial calx and vitriolic ſelenite, it is plain that the compound is very different from JAMES's Powder.

The next experiment with chalk and antimony, which Dr. BLAGDEN had the goodneſs to ſuggeſt, would lead to ſeveral concluſions, but I ſhall only take notice of the compoſition produced.

EXP. XI. 1200 grains of antimony were mixed with 800 grains of well waſhed, dried, and pulverized chalk, and calcined as in making LILE's Powder. In leſs than an hour the ſmell of ſulphur diſappeared; after which the mixture was calcined half an hour longer. It afforded a lighter clay-coloured powder than the calcination of antimony with bone-aſhes; and weighed 1800 grains. By expoſure to 100° of fire this powder changed to a dirty white colour. On examination, inſtead of aërated lime or chalk, there was found vitriolic ſelenite, part of which was probably combined with the antimonial calx; for, by means of boiling water repeatedly applied till the lixivium did not become turbid with muriated barytes nor acid of ſugar, I could only obtain 12 *per cent.* of vitriolic ſelenite, mixed with a little antimonial calx; but by means of nitrous acid I ſeparated 45 *per cent.* of this ſelenite, with ſcarcely any antimonial calx in it. The reſiduum, after this ſolution in nitrous acid, was calx of antimony with a little vitriolic ſelenite ſeemingly vitrified. Accordingly the compoſition may be ſtated to conſiſt of 1000 parts of antimonial calx and 950 parts of vitriolic ſelenite which I infer from the quantity of ſelenite diſſolved by the nitrous acid, and eſtimated to remain united to the calx; and from the following calculation of the proportion of theſe two ingredients formed in the experiment.

Anti-

Antimony.		Sulphur.		Air.			
1200	−	300	+	100	=	1000	Antimonial calx.
Calcar. earth.		Aerial acid.		Vitriolic acid.			
800	−	300	+	450	=	950	Vitriolic ſelenite.
						1950	
Loſs by ſublimation and waſte						150	
						1800	

With regard to the nature of this calx, the greateſt part of it readily diſſolved in marine acid; and part of what then remained was alſo diſſolved, but with great difficulty and very ſparingly; a minute quantity reſiſted ſolution entirely.

EXP. XII. 600 grains of coarſely powdered antimony were mixed with 400 grains of purified white ſand, and calcined as in making LILE's Powder. The ſmell of ſulphur continued for one hour and a half, and the mixture was calcined for half an hour longer. On cooling, a brown powder was obtained which weighed 820 grains, and expoſed to 100° of fire, melted into an irregularly figured, blackiſh maſs, full of cavities.

In this experiment the loſs of weight correſponds nearly to that in experiments above related, *viz.* thoſe in which the deficiency of weight after calcining antimony alone was about 29½ *per cent.* The much longer time required in this experiment for carrying off the ſulphur than in the calcinations with bone-aſhes, gypſum, and chalk, perhaps is owing to there being no affinity between antimonial calx and ſiliceous earth.

I beg leave to mention one more experiment relative to JAMES's Powder.

EXP. XIII. A medicine is ſold by F. NEWBERY, under the title of "JAMES's Powder for Horſes, Horned Cattle, Hounds, &c." It is a light clay-coloured, gritty, taſteleſs ſubſtance, in which

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are ſeen ſmall *ſpicula.* It appears to me to be nothing more than JAMES's Powder for Fevers, or LILE's Powder above-mentioned, made by calcining antimony and bone-aſhes together in open veſſels; becauſe, 1ſt, by expoſure to a white heat in cloſe veſſels, it turns as white as JAMES's Powder. 2dly, It diſſolves partially in nitrous acid; and the remainder diſſolves partially in marine acid. The nitrous ſolution contains phoſphoric acid and calcareous earth; and the muriatic ſolution affords Algaroth powder.

From the whole of the above *analytical experiments* it appears:

1. That JAMES's Powder conſiſts of phoſphoric acid, lime, and antimonial calx; with a minute quantity of calx of iron, which is conſidered to be an accidental ſubſtance.

2. That either, theſe three eſſential ingredients are united with each other, forming a triple compound, or, phoſphorated lime is combined with the antimonial calx, compoſing a double compound in the proportion of about 57 parts of calx and 43 parts of phoſphorated lime.

3. That this antimonial calx is different from any other known calx of antimony in ſeveral of its chemical qualities. About three-fourths of it are ſoluble in marine acid, and afford Algaroth powder; and the remainder is not ſoluble in this menſtruum, and is apparently vitrified.

From the preceding *ſynthetic experiments* it appears, that by calcining together bone-aſhes, that is, phoſphorated lime, and antimony in a certain proportion, and afterwards expoſing the mixture to a white heat, a compound was formed conſiſting of antimonial calx and phoſphorated lime, in the ſame proportion, and poſſeſſing the ſame kind of chemical properties, as JAMES's Powder.