XV. *Experiments to ſhew the Nature of* Aurum Moſaicum: *By Mr.* Peter Woulfe, *F. R. S.*

Read, Feb. 14. 1771. THE Aurum moſaicum is known by the names of Aurum muſivum, Aurum muſicum, and Purpurina. We can collect but very imperfect ideas of this preparation, from the writings of antient and modern chemiſts. It is true, that the method of making it has been deſcribed by many; but no one hitherto has led us into the knowledge of its nature, by a ſufficient number of experiments. It has been much uſed formerly as a pigment, but is now almoſt laid aſide, and the Bronzes ſubſtitued in its place. It is ſometimes uſed in medicine as a vermifuge, but how improper and uncertain it is for that purpoſe, will appear by the following experiments.

The beſt preparation deſcribed hitherto for making Aurum moſaicum, is ſet down in the London Diſpenſatory, and is as follows.

Take of tin twelve ounces, of flowers of ſulphur ſeven ounces, of ſal ammoniac ſix ounces, and of purified mercury ſix ounces; melt the tin, and add the mercury to it; and when cold, powder it, and mix with it the ſal ammoniac and ſulphur. Sublime the mixture in a matraſs. The Aurum moſaicum will

will be found under the ſublimate, with ſome droſs at the bottom *.

Ætiology of the Operation.

As ſoon as the mixture grows warm, the tin acts on the ſal ammoniac, and ſets free its volatile alkali; and this, having a great affinity with ſulphur, joins with a great part of it †, riſes in the ſublimation, and is totally diſſipated. The portion of tin, which acted on the Sal ammoniac and ſet free its volatile alcali, unites with the acid of ſalt of the ſal ammoniac, and forms a ſalt of tin, which ſublimes ‡. The mercury, which was added only in order to divide the tin, unites with ſome of the ſulphur, and likewiſe ſublimes and forms a cinnabar. The tin which remains, unites with the remaining ſulphur, and forms the Aurum moſaicum, which is found in the bottom of the matraſs. Inſtead of performing this operation in a matraſs, I have uſed a glaſs retort, fixed in a black lead crucible, with ſand round it; the crucible was put into a proper furnace, and a charcoal

* The proportion formely uſed was equal parts of each, which in the quantity of tin here employed, viz. ℥ 12, produced only ℥ 13½ of Aurum moſaicum; whereas the ſame quantity of tin in the proportion of the London diſpenſatory afforded ℥ 16.

Troy weight was made uſe of in all the following experiments.

† Sulphur combined with volatile alcali forms a volatile liver of ſulphur, called by Mr. Boyle volatile tincture of ſulphur and quick lime.

‡ Filings of tin, calx of tin, or tin divided by amalgamation with mercury, diſtilled with ſal ammoniac, &c. decompoſes it, whereby its acid of ſalt unites with the tin, and its volatile alkali is ſet free.

fire made round it, an adopter was luted to the retort, and to the adopter a quilled receiver; a long vial was fitted to the quill of the receiver, in order to hold the liquor that diſtilled.

It will be eaſy by this apparatus to perform the operation without any conſiderable loſs, provided the fire be well regulated. It is neceſſary to make a very ſlow fire at firſt, in order to condenſe the volatile fumes; for a great quantity of air is ſet free, when the ingredients begin to act on one another. The fire ſhould be rather ſlow for the firſt four or five hours, and then gradually encreaſed, until the crucible becomes moderately red hot; in which ſtate it is to be continued during the reſt of the operation, which commonly laſts about ſixteen hours from the beginning to the end.

If this operation be performed for the ſake of the Aurum moſaicum only, or for its ſublimate, it may as well be done in a matraſs or body; and in that caſe there is no great loſs of the ſublimate.

Twelve ounces of tin with ſulphur, ſal ammoniac and mercury in the proportion of the London diſpenſatory, prepared in this manner produced,

	℥ ʒ ℈
* Of volatile liver of ſulphur, liquid and dry	1 4 2
Of ſublimate found in the retort and adopter	13 2 0
Of Aurum moſaicum	16 0 0
Loſs in the operation	0 1 1
Weight of all the ingredients	℥ 31 0 0

* The volatile liver, for the moſt part, comes over liquid, and is often found in the long vial in form of moſt beautiful ramifications, which are a cryſtallization of the volatile liver.

The

This operation was often repeated, and always with ſome little variation in the products, owing to the management of the fire, which cannot be always made alike.

If this preparation be made with too great a degree of fire, the Aurum moſaicum will be partly melted, or of a dark colour; and if the fire be not continued for a ſufficient time, a portion of the cinnabar and ſalt of tin will remain with the Aurum moſaicum.

The Sublimate of Aurum moſaicum examined.

The ſublimate, which was obtained in preparing the Aurum moſaicum weighing ℥ 13 3 2 was finely powdered and digeſted with diſtilled water ſharpened with ſome acid of ſalt *, and when cold was filtered; more water was added to what remained in the filter, by which means it was deprived of its ſoluble part.

† The undiſſolved part of the ſublimate dried, and then ſublimed in a retort, produced ℥ 9½ of cinnabar, which was of a dark colour, owing to an exceſs of ſulphur; there came over into the receiver a ſmall quantity of an acid liquor, and there was found in the retort ℥ ½ of Aurum moſaicum, which added to the former quantity makes ℥ 16½.

The ſoluble part of the ſublimate is compoſed of tin united to the acid of ſalt; in order to know the quantity of tin which it contains, a ſufficient quantity of fixed alcali diſſolved in water was added

* Salt of tin mixed with water becomes turbid, and a portion of the tin precipitates; therefore the acid of ſalt was added, to prevent the precipitation.

† This contains ſome running mercury; but in the ſublimation it diſappears, and forms cinnabar.

to it, by which means the tin was precipitated; this precipitate weighed ℥ 2 ℥ 7.

An ounce of tin diſſolved in the acid of ſalt *, being precipitated with a ſolution of fixed alcali in water, well waſhed and dried † weighed ℥ 1 ¼; ſo that a precipitate of tin contains only $\frac{4}{5}$ of tin, and therefore the ℥ 2 ℥ 7 of precipitate obtained from the ſublimate contain only ℥ 2 ℥ 2 ½ nearly of tin; this being deducted from ℥ 12, the quantity of tin uſed in the operation, makes ℥ 9 ℥ 5 ½, which is the real quantity of tin contained in the ℥ 16 ½ of Aurum moſaicum obtained in this proceſs; therefore ℥ 1 $\frac{7}{10}$ of Aurum moſaicum contains ℥ 1 of tin, and ℥ $\frac{7}{10}$ of ſulphur; for ℥ 9 ℥ 5 ½ of tin is to ℥ 16 ½ of Aurum moſaicum, as ℥ 1 of tin is to ℥ 1 $\frac{7}{10}$ nearly of Aurum moſaicum. This will be further illuſtrated by other experiments.

The tin, which was precipitated by adding a fixed alkali to the ſoluble part of the ſublimate, was diſtilled with iron filings and fixed alkali; but no mercury was obtained. This ſhews that none of the mercury unites with the acid of the ſal ammoniac.

There was no volatile alkaline ſmell produced by the addition of fixed alkali to the ſoluble part of the ſublimate, though there were an exceſs of it added; which proves that the ſal ammoniac was totally decompoſed.

* The vapour, which ariſes in diſſolving tin in the acid of ſalt, becomes inflammable, when the ſolution is made in large quantity, by means of heat; the like happens alſo with regard to lead.

† This precipitate, if dried with too much heat, takes fire, and burns like a dried plant that contains nitre.

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The ſoluble part of the ſublimate of Aurum moſaicum produces cryſtals of an irregular form, which do not deliqueſce in the air like all other ſalts of tin, owing chiefly to their having a leſs portion of acid. A drop of the ſolution of this ſublimate, cryſtalliſed on a piece of glaſs, and viewed with a microſcope, has very much the appearance of the cryſtals of alum.

Aurum moſaicum, when well prepared, is of a ſhining golden colour, has no taſte, and is not ſoluble in water. It is not acted on by acids, nor by fixed or volatile alkalis diſſolved in water. If melted with an equal quantity of fixed alkaline ſalt of tartar, it forms a liver of the colour of gumbouge, which is, for the moſt part, ſoluble in water, and may be precipitated by any acid.

If Aurum moſaicum be diſtilled with iron filings, no mercury will be obtained.

It is well known, that tin deflagrates violently with nitre; therefore it will not ſeem ſurpriſing, that the Aurum moſaicum ſhould have that property in a far greater degree, it being a compoſition of tin and ſulphur *.

Sulphur, combined with metallick ſubſtances, renders them inactive, as we ſee in cinnabar, antimony, &c.; therefore Aurum moſaicum well prepared muſt be a very unfit medicine for worms.

Aurum moſaicum is often found to have a very rough taſte; but that is owing to the ſalt of tin, which has not been ſufficiently diſſipated in the ſublimation, and, in that ſtate it may effectually deſtroy

* May not this ſubſtance be uſeful in fire-works, as alſo ſulphurated iron?

worms;

worms; but it muſt be allowed to be a very uncertain medicine, and perhaps dangerous, as it may contain too ſmall or too great a quantity of the ſalt of tin.

If ſalt of tin be good for worms, it would be right to aſcertain its doſe, and give it in a proper vehicle.

Tin combined with Sulphur, by Fuſion.

Four ounces of tin melted and ſaturated with ſulphur weighed ℥ 5, and formed a black ſhining flaky brittle ſubſtance when melted. The tin need not be made quite red hot for this operation; for, when the ſulphur is mixed with it, a deflagration enſues, and the mixture grows red hot. In order to ſaturate the tin with as much ſulphur as poſſible, it muſt be added to it at two or three different times. The tin, notwithſtanding, cannot be, by this means, perfectly ſaturated with ſulphur; for after powdering and ſifting it, there remains in the ſieve a portion of the tin, which will flat under the peſtle, and not powder any more, unleſs melted and combined with more ſulphur. If this operation be done with too great a degree of fire, the increaſe of weight will not be ſo conſiderable, on account of the great fire, which diſſipates ſome of the ſulphur.

Four ounces of Aurum moſaicum melted in a covered crucible loſes ℥ 6 of its weight, and becomes a maſs ſomewhat like melted ſulphurated tin, though it be not ſo ſhining, nor ſo flaky, but rather more of a needle form. If the fuſion be repeated two or three times, ſome of its ſulphur will be each time diſſipated, and have exactly the appearance of ſulphurated tin.

Aurum

Aurum moſaicum melts much more readily than ſulphurated tin; and that, becauſe it contains a greater quantity of ſulphur.

Sulphurated tin, by calcination, is totally deprived of its ſulphur and phlogiſton. ℥ 4 of tin ſaturated with ſulphur, and then carefully calcined weighed ℥ 4½, ſo that a calx of tin prepared in this manner, weighs ⅛ more than the tin it contains *.

Four ounces of Aurum moſaicum calcined in the ſame manner, weighed ℥ 3, ʒ 2, ℈ 1, which, being a calx of tin, of the nature of that made with ſulphurated tin, contains ⅛ leſs of tin, which ⅛ being deducted, makes ℥ 2, ʒ 7, ℈ 1, gr. 4½, the quantity of tin contained in ℥ 4 of Aurum moſaicum †. An ounce of Aurum moſaicum carefully calcined, and reduced with flux, produced only ℥ ½ and gr. 11 of tin: we may conclude from the foregoing experiments, that ℥ 1 of Aurum moſaicum contains more than this quantity of tin; but it is well known that metallick bodies, which have been much calcined, and eſpecially tin and zinc, always loſe in their reduction.

Aurum moſaicum will be of a black colour, if too ſmall a quantity of ſulphur be uſed, and if the fire be too ſtrong and too long continued †.

* All metallick ſubſtances, and even zinc, though a good deal of it diſſipates in flowers, increaſe in weight by calcination.

† It is almoſt impoſſible to calcine Aurum moſaicum, without ſome loſs; for it is ſo light and ſubtil, that it cannot be ſtirred without diſſipating ſome of it; therefore the quantity of tin which it contains, cannot be exactly aſcertained by this means.

Receipts for making Aurum Moſaicum without Mercury.

1ſt. Take ℥ 8 of granulated tin ſifted through a fine ſieve, and mix it well with ℥ 6 of ſulphur, and ℥ 4 of ſal ammoniac; put the mixture into a matraſs or body, and calcine it for ſix or ſeven hours. The Aurum moſaicum hereby obtained is not of ſo bright a colour, as that made in the uſual manner; and that, on account of the tin not being ſufficiently divided in order to unite well with the ſulphur.

2d. Take ℥ 8 of tin reduced to a calx by calcination, and mix it well with ℥ 7 of ſulphur, and ℥ 4 of ſal ammoniac; calcine it as the former. This makes a good coloured Aurum moſaicum, though it be found here and there of an unequal colour, owing to ſome of the tin, which had been too much calcined, and thereby prevented from uniting with the ſulphur.

3d. Take ℥ 8 of tin, and ſaturate it by fuſion with ſulphur, powder and mix it well with ℥ 5 of ſulphur, and ℥ 4 of ſal ammoniac; calcine the mixture as before. This produces a good coloured Aurum moſaicum.

Receipts for preparing Aurum Moſaicum, without Mercury or Sal ammoniac.

1ſt. Take ℥ 8 of tin, ſaturate it by fuſion with ſulphur, and mix it with ℥ 4 more of ſulphur, and calcine as before, but with a leſs degree of fire. This forms rather a dark coloured Aurum moſaicum, owing to the ſulphur which melts, and in great meaſur e

meaſure ſeparates and ſwims on the ſurface of the ſulphurated tin.

2d. Take ℥ 10 of ſulphurated tin, powder and mix it well with ℥ 4 of ſulphur, and ℥ 2 of ſpirit of ſalt; calcine the mixture as the former. This forms an Aurum moſaicum of a tolerable good colour. This mixture ſoon grows warm of it ſelf after being put into the body, and produces a penetrating vinous ſmell, no ways like that which is afforded by diſſolving tin in the acid of ſalt.

In this operation, part of the tin unites with the acid of ſalt, and is at laſt diſſipated in the operation.

3d. Take ℥ 8 of tin, and ſaturate it with ſulphur, powder and mix it with ℥ 5 of ſulphur; put it into a body, and pour on it ℥ 2 of volatile liver of ſulphur obtained in making Aurum moſaicum, and calcine it as fore. This does not make ſo good a coloured Aurum moſaicum as the former, owing to the fuſion of the ſulphur, which in great meaſure ſeparates from the ſulphurated tin. Soon after the volatile liver was poured on the mixture of ſulphurated tin and ſulphur, it grew ſo hot that the body could ſcarcely be held in the hand.

4th. Take ℥ 4 of tin, ſaturate it with ſulphur, powder and mix it well with ℥ 2 of ſulphur, and ℥ 1 of tin diſſolved in the acid of ſalt and cryſtalliſed; calcine it as uſual. This produced ℥ 6½ of very good and quite taſteleſs Aurum moſaicum, ſo that ℥ 4 of tin by its union with ſulphur encreaſed in weight ℥ 2 ½.

This operation was done in a retort, to which there was luted an adopter and receiver, in order to collect

the ſalt of tin, which for the moſt part came over congealed.

5th. Take ℥ 10 of ſulphurated tin, powder and mix it well with ℥ 16 of corroſive mercury ſublimate; put it into a retort, to which an adopter and receiver is to be luted, calcine it for ſix hours, at firſt with a middling fire, and for the laſt three hours the retort muſt be red hot.

In this operation, a portion of the tin unites with the acid of the mercury ſublimate; and forms the ſmoaking liquor of Libavius, which diſtills for the moſt part in a liquid form; the mercury contained in the mercury ſublimate unites with a ſmall portion of ſulphur (about $\frac{1}{7}$ of its weight), and ſublimes in form of cinnabar in the top of the retort; the remaining tin, having a ſufficiency of ſulphur, forms the Aurum moſaicum, which is found at the bottom of the retort of a moſt beautiful ſparkling golden colour.

The reaſon for obtaining Aurum moſaicum by this operation is, that the greateſt part of the tin unites with the acid of the mercury ſublimate, and riſes in diſtillation; the remaining tin has thereby a ſufficient quantity of ſulphur to form the Aurum moſaicum.

Some of the foregoing receipts did not well ſucceed at the firſt or ſecond trial; and many other experiments, which did not anſwer, have here been omitted.

From the foregoing experiments, we may certainly conclude, that Aurum moſaicum is a combination of tin and ſulphur; it contains better than $\frac{1}{3}$ of ſulphur. It alſo appears that the only uſe of the mercury,

mercury is to divide the tin; and that the ſal ammoniac ſerves only to prevent the fuſion of the ſulphur.

The following proportion will anſwer better than that of the London Diſpenſatory; for there will be a greater produce of Aurum moſaicum, though a leſs quantity of mercury and ſal ammoniac be uſed.

Tin ℥ 12, ſulphur ℥ 7, ſal ammoniac ℥ 3, and mercury ℥ 3.

This proportion yields ℥ 17½ of Aurum moſaicum, whereas that of the London Diſpenſatory gives only ℥ 16.

The ſoluble part of the ſublimate of Aurum moſaicum anſwers far better for dying than any ſolution of tin; a ſmall quantity of it with cochineal will dye ſilk, and eſpecially cloth, of a fine ſcarlet colour; ſilk may be dyed of a fine crimſon colour, by its means, with the addition of brazil wood, peach wood, or braziletto; but with logwood, ſilk and cloth may be made of a great variety of fine purple colours, which ſeem laſting.

The property, which this ſublimate has of making finer colours than any ſolution of tin, engaged me to make many trials, with other preparations of tin; and I found, that when tin was united to the acid of ſalt, and diſtilled or ſublimed, it would produce finer colours than any ſolution or combination of tin, unſublimed or undiſtilled.

I muſt be excuſed for the preſent, for not telling the reaſon of this; it may be diſcovered by examining well the products, which are obtained by making the liquor fumans of Libavius, in the common manner.

May not iron and copper, united to the acid of ſalt and ſublimed, anſwer better for dying, than other preparations of iron and copper?

Moſt other metallick ſubſtances may be after this manner more intimately combined with a greater portion of ſulphur than by fuſion. Biſmuth is the only one, which produced a golden colour, and that not ſo fine a one as Aurum moſaicum. Iron, copper, lead, and regulus of antimony, produce black combinations; arſenic forms a reddiſh maſs like realgar; zinc does not in this manner, nor in any other way that I know, combine with ſulphur.

An Apparatus for making Aurum Moſaicum in the cheapeſt manner.

A glaſs veſſel cannot be uſed for this operation more than once, becauſe it is neceſſary to break it, to get out the Aurum moſaicum. The following utenſil may be employed a great number of times, and ſave the expence of glaſs.

Take a black lead crucible, N°. 60; bore a round hole in its bottom about three inches diameter; and ſaw off an inch of its upper edge; if it has a lip, get a round piece of burnt clay, of an inch thick or rather more, to fit exactly into this edge; the compoſition, which is uſed for making paving-tiles, anſwers very well for this purpoſe. In order to make uſe of this apparatus, fit the round piece of burnt clay to the inner edge of the crucible, by means of ſome loam ſoftened with glue, and dry it ſlowly; then turn it upſide down, and lay it in a proper furnace on two iron bars. The mixture for the Aurum moſaicum is to be put in through the round

round hole at top, and then covered with an aludel and luted; this ſerves to collect the flowers and the ſublimate which riſes. The fire is to be made under and all round the crucible. 11 ℔. Troy of Aurum moſaicum may be made here at a time; and when the operation is over, the bottom or round piece of burnt clay will eaſily come out with the Aurum moſaicum. A large crucible may be made uſe of, if a larger quantity be required to be made at once. The operation cannot fail of ſucceſs, provided the fire be made of a ſufficient ſtrength, and of an equal degree from the bottom to the top of the crucible, which is eaſily done in a good furnace. The operation is finiſhed in eight hours, unleſs the volatile liver is wanted.

White arſenic, digeſted with a ſolution of tin in the acid of ſalt, becomes ſoon black; it does hereby regain its phlogiſton, and is reduced to the ſtate of regulus of arſenic, and will by this means readily combine with copper, and other metallick ſubſtances; which it would not do, without the help of phlogiſtic ſubſtances. This is the moſt eaſy and ready way of reducing arſenic to its metallick form: the arſenic may be deprived of the ſolution of tin, which adheres to it by waſhing it with water. It is to be dried ſlowly, for otherwiſe it is apt to catch fire.

A Method of dying Wool and Silk, of a yellow colour, with Indigo; and alſo with ſeveral other blue and red colouring Subſtances.

THE Saxon blues have been known for ſome time; and are made by diſſolving indigo in oil of

vitriol, by which means the indigo becomes of a much more lively colour, and is extended to ſuch a degree, that it will go very far in dying.

A receipt for making the beſt Saxon blue will, I dare ſay, be agreeable to many; I will, therefore, give the following, which produces a very fine colour, and never fails of ſucceſs.

Mix ℥ 1 of the beſt powdered indigo, with ℥ 4 of oil of vitriol in a glaſs body or matraſs: and digeſt it for one hour with the heat of boiling water, ſhaking the mixture at different times; then add ℥ 12 of water to it, and ſtir the whole well, and when grown cold filter it. This produces a very rich deep colour; if a paler blue be required, it may be obtained by the addition of more water. The heat of boiling water is ſufficient for this operation, and can never ſpoil the colour; whereas a ſand heat, which is commonly uſed for this purpoſe, is often found to damage the colour, from its uncertain heat.

Indigo, which has been digeſted with a large quantity of ſpirit of wine, and then dried, will produce a finer colour than the former, if treated in the ſame manner, with oil of vitriol.

No one, that I know of, has heretofore made uſe of the acid of nitre, inſtead of the acid of vitriol; and it is by means of the former that the yellow colour is obtained: it was nevertheleſs natural to uſe it, on account of its known property of making yellow ſpots, when dropped on any coloured cloth.

The acid of ſalt does not diſſolve indigo, and therefore is of no uſe in dying.

Receipt

Receipt for making the yellow dye.

Take ℥ ½ of powdered indigo, and mix it in a high glaſs veſſel, with ℥ 2 of ſtrong ſpirit of nitre, previouſly diluted with ℥ 8 of water; let the mixture ſtand for a week, and then digeſt it in a ſand heat for an hour or more, and add ℥ 4 more of water to it; filter the ſolution, which will be of a fine yellow colour.

Strong ſpirit of nitre is liable to ſet fire to indigo; and it is on that account that it was diluted with water, as well as to hinder its frothing up. ℥ 2½ of ſtrong ſpirit of nitre will ſet fire to ℥ ½ of indigo; but, if it be highly concentrated, a leſs quantity will ſuffice.

If the indigo be digeſted twenty four hours after the ſpirit of nitre is poured on it, it will froth and boil over; but, after ſtanding a week or leſs, it has not that property.

One part of the ſolution of indigo in the acid of nitre, mixed with four or five parts of water, will dye ſilk or cloth of the paleſt yellow colour, or of any ſhade to the deepeſt, and that by letting them boil more or leſs in the colour. The addition of alum is uſeful, as it makes the colour more laſting; according as the ſolution boils away, more water muſt be added.

None of the colour in the operation ſeparates from the water, but what adheres to the ſilk or cloth; of conſequence this colour goes far in dying.

Cochineal, Dutch litmus, orchel, cudbear, and many other colouring ſubſtances treated in this manner, will all dye ſilk and wool of a yellow colour.

The indigo which remains undiſſolved in making Saxon blue, and collected by filtration, if digeſted with ſpirit of nitre, dyes ſilk and wool of all ſhades of brown inclining to a yellow.

Cloth and ſilk may be dyed green with indigo; but they muſt firſt be boiled in the yellow dye, and then in the blue.