

ther, I shall endeavour to procure them subscribers to their work, and shew them every civility in my power.

LXXXVI. *Experimental Examination of a white metallic Substance said to be found in the Gold Mines of the Spanish West-Indies, and there known by the Appellations of Platina, Platina di Pinto, Juan Blanca.* By William Lewis, M. B. F. R. S.

P A P E R I.

Read May 30, 1754.

Experiment I.

THE substance brought into England under the name of *platina* appears a mixture of dissimilar particles.

The most conspicuous, and by far the largest part of the mixt, are, white, shining grains, of seemingly smooth surfaces, irregular figures, generally planes with the edges rounded off. Upon examining these with a microscope, the surface appear'd in some parts irregular; the prominencies smooth, bright, and shining; the cavities dark-colour'd and roughish. A few of them were attracted, tho' weakly, by a magnetic bar.

The grains above describ'd are the true *platina*. The heterogeneous matters intermingled among them, in the several parcels, were,

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1. A blackish dust, separable by a fine sieve. This was farther divided, by a magnetic bar, into two different substances: the part attracted, was of a fine sparkling black colour, much resembling the black sand from Virginia: the part not attracted was of a dark brownish hue, with several bright *moleculæ*, which appear'd to be fragments of the grains of platina.
2. Among the larger grains, separated by a coarse sieve, were observ'd sundry irregular dark-colour'd particles, some blackish, others with a cast of brownish red, in appearance resembling fragments of emery or loadstone. Several were attracted, weakly, by the magnet.
3. There were a few rough yellow particles, resembling gold, which upon farther examination they were found to be, tho' probably not entirely free from platina.
4. A few globules of quicksilver, containing gold, with some particles of platina intermix'd and pretty strongly adhering.
5. Some fine transparent particles, probably spar.
6. A very few irregular particles, of a jet-black colour. These broke easily, and look'd like the finer kinds of pitcoal. Laid on a red-hot iron, they emitted a yellowish smoke, and smelt like burning coal.

Remarks. 1. It appears from the foregoing observations, that this mineral has not come to us in its native form; being, probably, taken out of the mines in large masses, which have been broke, and treated with

with mercury, in order to extract the gold, of which possibly it at first contain'd a considerable quantity. The quantity left by the workmen is extremely small; some pounds of the mixt having yielded only a few grains. A moderate fire renders more of these golden particles discoverable, than can be seen at first; the mercury evaporating, by which several of them were concealed.

2. Some part of the brownish powder is probably adventitious, as well as the mercury; being worn off from the stampers and mills employ'd for comminuting the mineral, and trituring it with the mercury.

3. The roughness and dark colour of the cavities of the grains of platina seem to proceed from a substance similar to the black dust, adhering in them. It is probably owing likewise to this heterogeneous magnetic matter, that some of them are attracted by the loadstone.

Experiment 2.

Some of the purer grains of platina, by gentle strokes of a flat hammer, upon a smooth anvil, bore to be considerably flatten'd, without breaking or cracking about the edges: some quickly crack'd, and discover'd internally a close granulated texture. All are reducible, by rude strokes in an iron mortar, tho' with difficulty, into powder. They seem'd to be rather more brittle when ignited, than when cold.

Experiment 3.

The specific gravity of platina, with its heterogeneous admixtures, as brought to us, was found to be

be to that of water as 16.995 to 1.000. The quantity weigh'd for this purpose was no less than 2000 Troy grains.

The larger grains of platina, separated as much as possible from the other matters by the sieve, and cleans'd by heating, boiling in aqua fortis, mixing them with sal ammoniac, and forcing off the salt by fire, and afterwards washing them; weigh'd in air 642, in water 606.75: whence their gravity turns out 18.213. The microscope still discover'd a considerable portion of blackish matter in their cavities.

These trials were several times repeated on different parcels of platina: the result was nearly the same in all.

Remark. The gravity of this mineral, great as it appears to be from the foregoing experiments, would probably turn out still greater upon a farther purification of the platina, since it is manifestly mix'd with some of the lighter heterogeneous matters.

Experiment 4.

1. A quantity of platina, containing its usual admixture of magnetic dust, was kept for some time of a moderate red heat in an iron ladle. The bright particles became somewhat duller-colour'd; the magnetic ones were no longer attracted. In other respects there was no sensible alteration.

2. An ounce of platina was urg'd with a strong sea-coal fire, in a blast-furnace, for above an hour: the heat was so vehement, that the black-lead crucible vitrify'd, and the slip of Windsor brick, which cover'd it, melted, and ran down. The grains of platina were found superficially cohering into a lump,

of the figure of the bottom of the crucible, of a brighter colour than at first. On a slight blow, they readily fell asunder again, and seem'd not to have alter'd their shape.

3. In several repetitions of the experiment, the platina began to cohere in a moderate white heat: the grains were at this time very easily separable, and seem'd to cohere the more strongly in proportion as the heat was rais'd. In the most intense fires, which the common vessels could not long support, the platina did not melt, or soften, or alter its figure, or lose, sensibly, of its weight. The colour was constantly brighten'd by a strong heat, and generally render'd dusky by a small one: on quenching it, when violently heated, in cold water, the grains, which compos'd the internal part of the lump, acquir'd a violet or purple colour.

Experiment 5.

1. As the power of fire upon metallic, as well as earthy substances, is remarkably promoted by the immediate contact of fuel, and the impulse of air upon the subject; platina was expos'd to its action in those circumstances. A crucible, having a bed of charcoal in it, was laid on its side, in a good blast-furnace, with its mouth towards the nose of the bellows; and four ounces of platina spread upon the charcoal. The fire was vehemently urg'd for above an hour, during which an intense white flame pass'd thro' the crucible, and issu'd at an aperture made for that purpose. The crucible was vitrify'd: the grains of platina only superficially coher'd, and became brighter, as in the preceding experiment, without seeming to have soften'd or alter'd their shape.

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2. The experiment was several times repeated, and varied : once, common salt was thrown on the fuel before the crucible, and its fumes strongly impell'd on the platina : some platina was likewise placed before the nose of the bellows in violently-excited sea-coal fires, so strong as to almost instantly melt off a piece of the end of a forg'd iron rod, without effect ; except that once there were a very few globular drops, about the size of very small shot : these broke easily on the anvil, and look'd, both internally and externally, like platina.

Remark. It is probable, that the fusion here was owing to some accidental admixture, possibly iron : for the unmelted grains, expos'd afterwards to a fire rather more intense, suffer'd no sensible alteration.

Experiment 6.

Platina was likewise expos'd to the fire in conjunction with several substances, which are found to promote the fusion of other bodies, or to occasion considerable alterations in them.

1. Platina mingled with powder'd charcoal, with compositions of charcoal, foot; common salt, and wood ashes, substances employ'd for changing iron into steel ; suffer'd no change in weight or appearance, whether urg'd with an intense fire, or cemented for many hours in a weaker one.

2. Platina was injected into melted borax, and urg'd with an intense fire for several hours, without undergoing any alteration. Nor had black flux, common salt, pure fix'd alkaline salts, or caustic alkalies, any sensible effect.

3. Vitreous matters were no more powerful than the saline. Platina was kept in strong fires, for several hours, with common green glass, with glass of antimony, and with glass of lead, without seeming to be in the least acted upon by either.

4. Platina was likewise stratified with plaster of Paris, a powerful flux for the most difficultly-fusible metallic body hitherto known, forg'd iron; as also with quicklime, and with calcin'd flint; with as little effect as in the former trials.

Experiment 7.

Nitre, which reduces all the known metallic bodies, except gold and silver, into a calx, was mix'd with an equal weight of platina, the mixture injected into a strongly-ignited crucible, and the fire kept up for a considerable time; no deflagration happen'd; and the platina, freed from the salt by repeated ablu-tions with water, prov'd of the same weight and appearance as at first.

Experiment 8.

1. An ounce of platina was spread upon twice its weight of sulphur, with which some powder'd charcoal had been previously mix'd to prevent its becoming fluid in the fire so as to suffer the platina to subside. The crucible, having another with a hole in the bottom inverted into its mouth, was kept in a cementing furnace for several hours, when the sulphur was found to have entirely exhal'd, leaving the platina separable from the charcoal by washing, without alteration or diminution.

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2. We likewise varied the experiment, injecting repeatedly pieces of sulphur upon platina strongly heated; and constantly found, that pure sulphur had no more effect upon this mineral than on gold itself.

3. As fix'd alkaline salts enable sulphur to dissolve gold; platina was expos'd to the fire with a mixture of sulphur and alcali, call'd *hepar sulphuris*. After a considerable heat had been continu'd for some time, and the matter occasionally stirr'd, very little of the platina was found remaining in its proper form; the greatest part being taken up by the sulphureo-saline mixture, so as to dissolve along with it in water.

General Remarks.

It appears, from the foregoing experiments and observations,

1. That probably this mineral is originally found in large, hard masses, compos'd of true platina, a substance similar to the black Virginia sand, and another ferruginous matter of the emery kind, some spar, and particles of gold.

2. That these masses are, not without great labour, reduced into small grains, which are afterwards ground with mercury, in order to extract the gold.

3. That the pure platina is a white metallic substance, in some small degree malleable: that it is nearly as ponderous as gold, equally fix'd and permanent in the fire, equally indestructible by nitre, unaffected by sulphur, dissoluble by *hepar sulphuris*. That it is not to be brought into fusion by the greatest degree of fire procurable in the ordinary furnaces, whether expos'd to its action in close vessels, or in contact with the fuel; by itself, or with the addition of inflammable, saline, vitreous or earthy fluxes.

P A P E R II.

Read June 20, 1754. **T**HE more obvious properties of this extraordinary mineral, and its *habitus* to fire, singly, and in conjunction with the various substances call'd by the chemists *fluxes*, made the object of the first paper. In this, it is propos'd to examine the effect of acid spirits, simple and compound, applied after various manners; in order to determine not only its relation or *habitus* to them, but likewise its less obvious agreement or disagreement with the metallic bodies, whose history is more known.

The platina employ'd in the following experiments was previously freed from its fine dust by a sieve; from the mercury, by ignition; and from the golden and some of the other heterogeneous particles, by the eye assist'd with glasses.

*Experiment 1.**Platina with the Vitriolic Acid.*

1. Several parcels of platina were digested for some hours, in a gentle heat, with spirit of vitriol, both concentrated, and diluted with different proportions of water. No solution happen'd, nor any sensible alteration, either in the liquors or the platina.

2. Three ounces of well-dephlegmated spirit of vitriol were boil'd with one ounce of platina, in a tall, narrow-neck'd glass, for some hours. The liquor remain'd nearly of the same quantity as at first; and

no change could be perceiv'd either in it, or in the platina.

3. The glafs being cut off, a little above the liquid, the heat was gradually increas'd, till the liquor, which now began to evaporate, had, in five or fix hours, totally exhal'd, and the platina become dry, and red-hot. When grown cold, wafh'd with water, and exsiccated, it was found exactly of the fame weight as at first, and its grains not divided, or apparently alter'd.

Remark. Platina appears therefore to entirely resist the vitriolic acid ; which, by one or other of the above processes, dissolves or corrodes every other known metallic body except gold.

Experiment 2.

Platina with the Marine Acid.

1. Weak and strong spirits of salt being digested, separately, with one-third their weight of platina, in a gentle heat, for several hours, the liquors remain'd uncolour'd, the platina unalter'd, and undiminish'd. The heat was afterwards increas'd, and the liquors kept strongly boiling till they had totally exhal'd, without occasioning any sensible change in the platina.

2. Three ounces of a mixture of two parts decrepitated sea-salt and three parts of vitriol highly calcin'd, were press'd smooth into a crucible ; an ounce of platina spread evenly upon the surface, and cover'd with some more of the mixture ; the crucible closely luted, and kept in a moderate red heat for several hours. On examining it when grown cold, the saline

mixture was found to have melted, and form'd a smooth, uniform lump. The platina, which had sunk to the bottom, being separated from the mixture by washing, prov'd of the same appearance as at first, tho' a little deficient in weight.

3. The experiment was repeated with what is call'd the *regal cement*, a less fusible mixture, compos'd of common salt and colcothar each one part, and four parts of powder'd red bricks. An ounce of platina, surrounded, as above, with six ounces of this composition, and cemented in a close-luted crucible with a red heat, for twenty hours, was still found unalter'd in appearance, tho' there was some deficiency, as before, in the weight.

Remark. The marine acid, when thus detain'd in the fire by the combination of other bodies, till strongly heated, and then set at liberty in the form of fume, dissolves or corrodes all the known metallic substances, gold alone excepted. As the platina, in these experiments, retain'd its original polish'd surface, without any mark of corrosion; it was presum'd, that this mineral likewise had resisted the marine fumes; and that the deficiency was owing to some of the smaller grains having been wash'd off, along with the ponderous colcothar or metallic matter of the vitriol; an accident not easily avoided.

4. Platina was therefore treated with mercury-sublimate, a combination of the highly-concentrated marine acid with a volatile substance, which in a proper degree of heat it readily forsakes to unite with other metallic bodies. An ounce of platina was spread upon three ounces of powder'd sublimate; the glass cover'd, and set in sand: After a moderate fire for
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some hours, the sublimate was found to have entirely arisen, leaving the platina of its original weight, as well as appearance.

5. Fifty grains of a mixture of one part of platina and two of gold, well Neal'd, and cautiously hammer'd into a thin plate, were surrounded with regal cement, the vessel cover'd, closely luted, and kept for a considerable time in a red heat. Upon examining the metal, it was found to retain the whiteness and brittleness, which gold constantly receives from so large a proportion of platina; and to have lost in weight about half a grain, or one-hundredth.

Remark. The loss here appears to have proceeded, not from the platina, but from alloy in the gold employ'd, which was above standard, but not perfectly fine: For the metal cemented a second time, with fresh mixture, suffer'd no farther diminution. If the marine acid were capable of dissolving platina, instead of one-hundredth, nearly one-third would have been exceded. This experiment therefore determines, with certainty, the resistance of platina to the marine fumes; and that the regal cement, so call'd from its being suppos'd to purify gold from all heterogeneous metallic matters, is incapable of separating platina from it.

Experiment 3.

Platina with the nitrous acid.

1. Spirit of nitre diluted with water, proof *aqua fortis*, and the strong nitrous spirit, were digested separately, with one-third their weight of platina, in a gentle heat, for several hours. During the digestion,

some bubbles were observ'd, as if a solution was beginning : but the liquors acquir'd no colour ; and the platina, wash'd and dry'd, was found to have neither alter'd its appearance, or lost of its weight. The fire being afterwards increas'd, and the acid spirits kept strongly boiling till they had entirely evaporated, no change could be observ'd in the platina.

2. Platina was likewise treated with nitrous mixtures, by processes similar to those, in which it had been expos'd to the marine fumes. After cementation for many hours, in a red heat, with a mixture of three parts calcin'd vitriol, and two of melted nitre, the grains were recover'd not only unalter'd, but likewise without any deficiency in weight.

Remark. From these experiments it is plain, that platina, equally with gold, resists the force of the vitriolic, marine, and nitrous acids, tho' apply'd in such a manner, as to be capable of perfectly dissolving all other known metallic bodies.

Experiment 4.

Platina with aqua regia.

1. Aqua regia, which perfectly dissolv'd gold, pour'd upon platina, began to act on it in the cold, and, by the assistance of a moderate heat, slowly dissolv'd it ; acquiring at first a yellow colour, which deepen'd by degrees, as the menstruum became more saturated, into a dark brownish red. A few drops of the saturated solution tinged a large quantity of water of a fine golden colour.

2. The experiment was several times repeated with different aquæ regiæ, made by dissolving sea-salt and sal

fal ammoniac, separately, in four times their weight of aqua fortis; and by abstracting the nitrous spirit from the same proportion of each of the salts. With all these menstrua the solution seem'd to succeed equally.

3. In order to determine the quantity of menstruum necessary for the solution; three ounces of an extremely strong aqua regia, diluted with water, were pour'd upon one ounce of platina, in a retort, to which was adapted a recipient. A gentle heat being applied, the menstruum acted violently, and red fumes arose in abundance. When about two-thirds of the liquor had come over, the action was scarce, if at all, sensible, though the fire was considerably rais'd. The distill'd liquor, which appear'd of a light redish colour, being pour'd back again into the retort, the solution began afresh; the vapour, which now came over, appear'd pale, compar'd with the first. The cohobation was repeated four times, the distill'd liquor proving paler and paler every time: At length, both the fumes and action ceas'd, though the fire was rais'd, and a considerable part of the platina remain'd undissolv'd. The solution was therefore pour'd off, some more of the menstruum added, the distillation and cohobation renew'd, and this occasionally repeated, till the whole was taken up, excepting a little blackish matter, of which hereafter. The quantity of strong aqua regia, employ'd for dissolving the ounce of platina, was five ounces; but the last parcels appear'd from their yellow colour not to be fully saturated, and, upon trial, were found to take up near fifty grains of fresh platina.

Remark. It appear'd, that by this method of managing the process, one part of platina was dissoluble in about four and a half of aqua regia: But that when the digestion was perform'd in open vessels in the common manner, and the fumes, which arise copiously during all metallic dissolutions, suffer'd to exhale, more than half as much again of the menstruum was requisite. This process might therefore possibly be applicable to advantage, in making solutions of metals in the way of business.

Examination of Solution of Platina.

Experiment 1.

As the vitriolic acid carries down metallic bodies, gold not excepted, from their solutions in other menstrua; this acid was mix'd with solutions of platina.

1. When the solution of platina was previously diluted with water; the addition of dephlegmated spirit of vitriol occasion'd no precipitation, or change of colour, tho' a large quantity of the acid was, at different times, dropp'd in, and the mixture suffer'd to stand for several days.

2. Dephlegmated spirit of vitriol, added to an undiluted solution of platina, immediately render'd it turbid, and threw down a dusky-colour'd precipitate. The precipitate was not re-dissolv'd on the affusion of water; nor was the precipitation prevented by adding water immediately after the acid had been dropp'd in.

Experiment 2.

Solutions of platina, evaporated by a gentle warmth, to a proper pitch, and then set to shoot, yielded crystals, of a dark, almost opaque, red colour, in form of leaves, like flowers of benzoin, but thicker. The crystals, wash'd with proof spirit, became somewhat paler, but still remain'd of a high colour, resembling the deeper chives of saffron. Expos'd to the fire, they seem'd to melt, emitted white fumes, and at length fell into a dusky ash-colour'd calx.

Experiment 3.

Solutions of platina, dropp'd upon hot marble, immediately corroded it; but did not, like solutions of gold and some other metals, communicate any colour. Nor did they give any stain to the skin, to feathers, ivory, or other like animal substances, which liquors containing gold tinge purple.

Experiment 4.

As a minute proportion of gold contain'd in liquors is discoverable by their striking a purple colour with tin.

1. Some bright plates of pure tin were put into a solution of platina diluted with water. The plates, in a little time, look'd of a dark olive colour, and soon after were cover'd with a redish brown matter: The liquor became at first darker colour'd, and afterwards by degrees, as the precipitate fell, nearly colourless; without exhibiting the least appearance of a purplish hue.

2. Platina was digested in a quantity of aqua regia insufficient to dissolve the whole; and the residuum dissolv'd in a fresh parcel of the menstruum. The two solutions, treated as above, yielded somewhat different phenomena, but no tendency to a purplish cast could be perceiv'd in either. The latter, which looked yellow from not being fully saturated, was, when diluted with water, almost colourless. Nevertheless, on the addition of the tin, it became yellow again, then red, and at length of a dark brownish red considerably deeper than the other more saturated solution. On standing for some time, it grew perfectly clear, depositing a paler, yellowish precipitate.

3. To determine whether platina was capable of preventing a small proportion of gold from discovering itself on this trial, one drop of a solution of gold was let fall into several ounces of a solution of platina diluted with water. On adding some plates of tin, the whole became immediately of a fine purple.

Remark. It may be proper to observe, that in these kinds of experiments, plates of tin are far more eligible than the solutions of tin usually employ'd: For the solutions fail of striking a purple colour with solution of pure gold, unless certain circumstances are observ'd, which are not easily hit upon; but tin in substance constantly succeeds, and requires no particular precaution.

Experiment 5.

As gold is reviv'd from its solutions by inflammable spirits, the metal gradually arising to the surface, in form of a bright yellow cuticle;

1. A solution of platina was mix'd with a large proportion of highly-rectified spirit of wine, and expos'd for many days to the sun, in a wide-mouth'd glass, slightly cover'd with paper, so as to keep out dust. There was no appearance of any yellow skin; nor any other alteration, than that the platina had begun to crystallize from the evaporation of the fluid.

2. A drop or two of a solution of gold being added to a large quantity of a mixture of solution of platina and spirit of wine, and the whole expos'd as above to the sun; a golden film was in a few days observ'd upon the surface.

Remark. It follows from this experiment, and the foregoing one with tin, that platina contains no gold; and that it cannot, any more than the common metallic or other soluble substances, prevent a small proportion of gold mix'd with it from being discoverable.

Experiment 6.

1. The spirits of sal ammoniac, prepar'd both by quicklime and by fix'd alkaline salts, added to solutions of platina diluted with distill'd water, precipitated a fine red sparkling powder; which, excicated, and expos'd to the fire in an iron ladle, became blackish; without at all fulminating, which calces of gold, prepar'd in the same manner, do violently. On washing some of this precipitate upon a filter, by repeated affusions of water, the greatest part of it dissolv'd; only a small quantity of a blackish matter remaining, and the liquor passing through of a deep, bright, golden colour. A very large quantity of the
fluid

fluid was tinged of this colour by a small one of the powder.

2. Salt of wormwood, fix'd nitre, the *lixivium saponarium* of the London *pharmacopœia*, precipitated a powder similar to the foregoing, except that its colour was less brilliant.

3. Sal ammoniac likewise, one of the ingredients, to which the menstruum ow'd its power of dissolving the platina at first, precipitated great part of it in form of a similar powder.

4. The liquors remaining after all these precipitations with saline substances, appear'd of a yellow colour, almost as deep as before the precipitation. Fix'd and volatile alcalies being added alternately, the liquor still continu'd yellow: But either of them, added after sal ammoniac had perform'd its office, threw down a fresh precipitate, which left the liquor colourless.

5. The addition of tin likewise, after either of the salts separately had thrown down all they were capable of doing, occasion'd a fresh and complete precipitation; provided a little more of the menstruum was dropt in, to enable the liquor to act upon the metal.

Experiment 7.

As gold is totally precipitated by alkaline salts, but platina only in part; and as a minute portion of platina, remaining dissolv'd, tinges a surprisingly large quantity of the fluid of a yellow colour; it was presum'd, that a small admixture of platina with gold might by this means be readily discoverable.

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A few drops of a solution of platina were therefore mixed with above an hundred times the quantity of a solution of gold; the whole diluted with water; and a pure alkaline salt gradually added, as long as it occasioned any effervescence or precipitation. The remaining liquor was of so deep a yellow colour, that it was judged the platina would have discovered itself, though its proportion had been less than one thousandth part of that of the gold.

Experiment 8.

1. Zinc, which totally precipitates all the other known metallic bodies, put into a diluted solution of platina, was very quickly acted on, and threw down a blackish calx. The liquor in good measure preserved its yellow colour; a mark, that part of the platina remained suspended.

2. Iron, which precipitates all the metals from their solutions, except zinc, threw down a similar calx. It could not be judged by the eye, whether the precipitation was complete, the solutions of iron and platina nearly agreeing with one another in colour.

3. Copper, the precipitant of mercury and gold, readily threw down platina from its solution, in form of a greyish calx, which was found upon trial to retain a notable quantity of the copper. The liquor remaining after the platina had fallen was of a more dusky green than solutions of pure copper, probably from its retaining some of the platina.

4. Mercury, which precipitates gold alone from aqua regia, put into a diluted solution of platina, seemed in a little time to be divided, and did not

run freely. Soon after, it appeared covered with a greyish matter, which at first was apprehended to be a precipitate, but was found afterwards to be a part of the mercury corroded. Upon applying a moderate heat, the whole of the quicksilver, the quantity of which was very considerable, was dissolved, without any precipitation.

The experiment was repeated with a larger quantity of mercury than the solution was capable of taking up. The platina now gradually fell down among the undissolved quicksilver, in form of a dark brownish powder; leaving the liquor nearly colourless.

5. A solution of gold mingled uniformly with a solution of platina, without occasioning any turbidness or precipitation. The mixture, diluted with water, and suffered to stand for some time, threw up a bright golden pellicle to the surface.

Experiment 9.

1. A solution of platina, super-impregnated with as much mercury as it was capable of taking up, on being evaporated a little, so as to dispose it to shoot, yielded crystals not at all like those of platina, but in form of spicula, externally of a yellowish hue. These, slightly washed with proof spirit, became colourless: Exposed to the fire, they emitted copious white fumes, with a hissing or crackling noise; and left a very small quantity of a reddish powder.

2. A mixture of solutions of gold and platina, being treated in the same manner, ruby-coloured crystals were obtained, which appeared to be chiefly gold, with very little of the platina.

Remark.

Remark. It seems therefore, that mercury and gold crystallize from their solutions before platina, leaving greatest part of that mineral dissolved. This affair, particularly with regard to gold, deserves farther inquiry.

Experiment 10.

As the calces of metals, obtained by precipitation from acids or by other means, vitrify along with fritt or glass, and tinge them of various colours; and as this process is recommended by some for investigating the nature of unknown metallic bodies; the following trials were made with precipitates of platina.

1. Half an ounce of a precipitate thrown down from solution of platina by plates of pure tin, was triturated in an iron mortar with eight times its quantity of common white glass, the mixture put into a crucible, which was closely luted, and placed in a wind furnace. The fire was gradually raised, and kept up extremely strong for about ten hours; when, the crucible being taken out and broken, the matter appeared of a dark blackish colour, untransparent, easily friable; interspersed with a bright whitish matter, apparently metallic.

Remark. It is probable, that this metallic matter was the platina; and that the glass owed its opacity and dark colour, not to this mineral, but to the tin in the precipitate, some particles of iron abraded from the mortar, or other accidental causes.

2. A quarter of an ounce of a precipitate of platina, made by alkaline salt, was ground in a glass mortar with twelve times its weight of white glass; and committed to the same fire as the foregoing. The

result was a compact, cloudy glass, pretty transparent in thin pieces, covered in part with a thin whitish coat. Towards the upper part, and all round the sides, were observed several particles of metal; which appeared to the eye like bright platina, and proved hard to the point of a knife.

Remark. Nor does the glass here seem to have received any thing from the platina; the change being no other than what white glass is found to undergo from a slight impregnation with inflammable matter.

General Remarks.

It appears from the experiments related in this paper, that platina, like gold, is not acted on by the simple acids, which dissolve every known metallic body besides: That aquæ regia, the solvents of gold, prove likewise menstrua for platina: And that consequently the common methods of assaying or purifying gold by *aqua fortis*, *aqua regis*, or the *regal cement*, can no longer be depended on: That it differs from gold, in giving no stain to the solid parts of animals, not striking a purple colour with tin, not being revived from its solutions by inflammable spirits, not being totally precipitable by alkaline salts; that in certain circumstances it throws out gold from its solutions; that these properties afford means of distinguishing a small proportion of gold mixed with a large one of platina, or a small proportion of platina with a large one of gold; and that platina contains no gold, excepting the few particles distinguished by the eye: That platina is precipitated from its solutions by the vitriolic acid, and by the metallic substances, which precipitated gold, though scarce totally

totally by any: And that its precipitates resist vitrification, and this perhaps in a more perfect manner than precipitates of gold itself.

P A P E R III.

Read June
27, 1754.

THE two former papers have given an account of the *habitus* or relation of platina to the principal substances, which act upon metallic bodies; and shewn, that it is a simple metal, of a particular kind, essentially distinct from all those hitherto known, though possessed of some properties generally supposed peculiar to gold. Many of its distinguishing characters have been already pointed out: Others will result from combining it with the several metals; with each of which, notwithstanding its resistance to the most intense fires by itself, or with unmetallic additions, it melts perfectly; occasioning remarkable alterations in their colour, texture, and hardness.

A R T I C L E I.

Platina with Tin.

I. *Equal parts* of platina and pure tin were injected into a mixture of black flux and common salt in strong fusion; and urged with a quick fire, in a good blast furnace. After a few minutes the whole appeared perfectly melted; and on being instantly poured out, run freely along a narrow mould, forming a smooth ingot, nearly of the same weight with the platina and tin employed. The compound proved extremely brittle, breaking easily from a fall:

Inter-

Internally it appeared of a close and smooth, though uneven surface; and of a dark-grey colour. By the file, or a knife, it was readily scraped into a blackish dust.

2. *One* part of platina and *two* of tin, covered with black flux, borax and common salt, were melted in a wind furnace: The platina appeared perfectly taken up by the tin, soon after the fire had been raised to a light white heat. The ingot was found deficient in weight about one-ninetieth. It greatly resembled the foregoing, being only a little less brittle, and of a somewhat lighter colour.

3. *One* ounce of platina and *four* of tin, covered with black flux and common salt, and urged with a quick fire, melted together without loss. This compound yielded a little to gentle strokes of a flat hammer, but was by no means tough. It broke in pieces from a rude blow, and was still readily scraped into dust by a knife. The surface of the fracture was rough and granulated.

4. *One* part of platina and *eight* of tin, injected into a fluid mixture of black flux and common salt, united, without loss, into a pretty tough compound; which bore to be considerably flattened under the hammer without breaking, cut smooth with a thin chissel, and shaved with a knife. Broken, it appeared of a sparkling, dark-coloured, coarse-grained texture.

5. *One* part of platina and *twelve* of tin, treated in the same manner, formed a mixture tolerably ductile; but still of a dull, dark hue, and a rough coarse grain, though somewhat less so than the preceding.

6. A mixture of *one* part of platina and *twenty-four* of tin, proved not much stiffer than tin. The colour

colour was whiter, and the grain finer and evener, than those of the preceding compositions; though in both respects it fell considerably short of pure tin.

7. Several of these compositions, covered with black flux, which had been previously melted, were exposed, in crucibles closely luted, to a strong fire in a wind furnace, which was steadily kept up for eight hours. When taken out, they were all found to have suffered some diminution, amounting to about one-fortieth of the tin. In appearance and quality, there was no sensible alteration, except that the mixture seemed more uniform, and the grain a little finer.

8. The remarkable gravity of platina induced us to examine the several mixtures hydrostatically. Here it was found, that the specific weight of the compound constantly turned out less than the medium of the gravities of the two ingredients; and generally the more so, as the proportion of the platina was the greater.

		Specific Gravity.		
		By Experiment.	By Calculation.	Difference.
Platina	—	17. 000		
Platina 1,	Tin 1	10. 827	12. 090	1. 263
Platina 1,	Tin 2	8. 972	10. 453	1. 481
Platina 1,	Tin 4	7. 794	9. 144	1. 350
Platina 1,	Tin 8	7. 705	8. 271	0. 566
Platina 1,	Tin 12	7. 613	7. 935	0. 322
Platina 1,	Tin 24	7. 471	7. 573	0. 102
Tin	—	7. 180		

Remarks. It appears from the foregoing experiments, that platina melts with at least equal its weight of tin: That it destroys the malleability of
near

near four times its weight : That with larger proportions it forms compounds tolerably ductile, but renders the texture of the tin coarser, and debases its colour. The difference in colour of these compositions was much less conspicuous on the touchstone, than when the fractures of the ingots were examined ; though, on close inspection, they appeared all sensibly duller and darker than pure tin, and the more so, in proportion as the platina prevailed. They all tarnished in the air ; those least, which had a very small or a very large proportion of platina.

It is remarkable, that though tin is a metal very readily destructible by fire, yet in most of the preceding fusions, there was scarce any sensible loss of weight. This is to be attributed not solely to the admixture of the platina, but likewise to the flux made use of, and more particularly to the celerity and short continuance of the heat. In N^o 2 and 7, the only ones, in which the loss was at all considerable, the fire was slowly raised, and long continued.

A R T I C L E 2.

Platina with Lead.

1. *Equal parts* of platina and lead were injected into a mixture of black flux and common salt, previously melted together ; and the fire hastily raised by bellows. A much stronger heat was requisite than for the fusion of platina with an equal quantity of tin ; and the loss was considerably greater, amounting to about one-sixty-fourth. The metal yielded difficultly to the file ; broke, from a moderate blow, of a close texture, uneven surface, and rough jagged edges :

edges : The colour was very dark, with a faint purplish cast.

2. *One* part of platina and *two* of lead, covered with borax and black flux, and exposed to a gradual fire, in a wind furnace, did not come into fusion till the fire had been raised to a strong white heat : From the continuance of heat in this experiment the loss was great, being nearly one-twenty-fourth of the mixture. The ingot proved hard and brittle, like the preceding, but broke off a striated surface.

3. *One* ounce of platina and *three* of lead, treated in the same manner, required still a very strong fire for their perfect fusion ; and lost about one-twenty-sixth. The metal broke less easily than either of the preceding, and in some measure yielded to the hammer : The colour was somewhat darker, and inclined more to purplish.

4. *One* part of platina and *four* of lead, being covered with black flux and common salt, and committed to a wind furnace, the platina was not perfectly taken up, till the fire had been raised to a considerably strong white heat : The loss was one-fortieth. The same proportions of the metals, injected into a fluid mixture of the flux and salt, previously brought to the above degree of heat, almost instantly melted, and lost only one-hundred-and-sixtieth. The ingot was much tougher than of the foregoing, filed well, and cut tolerably smooth with a knife. Upon breaking, the upper part appeared composed of bright plates, the lower of dark purplish grains.

5. *One* part of platina and *eight* of lead united easily in a quick fire, and lost little or nothing. The metal worked and looked like very bad lead : On

breaking, the texture appeared partly composed of tranſverſe fibres, and partly of grains; the colour dull and purpliſh.

6. *One* part of platina and *twelve* of lead united, without loſs, into a compound very little different from the foregoing. On breaking, its texture was ſomewhat finer, and composed chiefly of fibres, with very few grains.

7. A mixture of *one* part of platina and *twenty-four* of lead proved not very much harder than lead of a middling quality. The colour was ſtill ſomewhat purpliſh, and the texture fibrous; but the fibres were remarkably finer than where the platina was in larger proportion.

8. The foregoing compositions, when newly poliſhed, appeared in general of a dark iron colour; which, upon expoſure to the air, quickly tarniſhed to a browniſh yellow, a deep purpliſh, and at length a blackiſh. They all filed freely, without ſticking in the teeth of the file, as lead does by itſelf.

9. Upon returning theſe compounds to the fire a ſecond time, it was conſtantly obſerved, that after they had come into perfect fuſion, if the heat was ſlackened a little, great part of the platina ſubſided: That nevertheleſs, the lead decanted off, even in a heat below ignition, retained ſo much of the platina, as rendered it of a fine fibrous texture, and purpliſh colour.

The ſeveral mixtures, covered with black flux, and kept in ſtrong fuſion, in crucibles cloſely luted, for eight hours, ſuffered a diminution in weight, amounting to about one-thirtieth of the lead. On breaking, thoſe with a large proportion of platina appeared

peared of a leafy, and those with a smaller, of a fine fibrous texture, which seemed in general to be characteristics of the perfect union of the platina and lead. They all looked whiter and brighter than at first, but tarnished sooner in the air. One mixture in particular, of four ounces of platina and twelve of lead, broke into large, white, bright, shining, talc-like flakes; which, on exposure to the air, changed in a little time to a reddish, a purple, and a deep blue; and at length turned slowly to a dark blackish colour.

10. On examining these compounds hydrostatically, their gravities turned out less than they ought to have been according to their calculation, but not so much less as those of the compositions of platina and tin.

	Specific Gravity.		
	By Experiment.	By Calculation.	Difference.
Platina —	17. 000		
Platina 1, Lead 1	14. 029	14. 193	0. 164
Platina 1, Lead 2	12. 925	13. 257	0. 332
Platina 1, Lead 4	12. 404	12. 509	0. 105
Platina 1, Lead 8	11. 947	12. 009	0. 062
Platina 1, Lead 12	11. 774	11. 818	0. 044
Platina 1, Lead 24	11. 575	11. 610	0. 035
Lead —	11. 386		

Remark. It appears, that a small proportion of platina is taken up and kept suspended by lead, in a very gentle heat; but that a large proportion is not taken up near so easily as by tin, and if united by a strong fire, subsides in part upon its abatement. A little quantity stiffens and hardens lead more than it

does tin; but a large one does not near so much diminish its malleability. A leafy or fibrous texture, a purplish colour or disposition to acquire this colour in the air, are peculiar to the mixtures with lead.

ARTICLE 3.

Platina with Silver.

1. *Equal parts* of platina and of pure silver received from *luna cornea*, covered with borax, and urged with a strong fire in a blast furnace, melted perfectly together, and without loss, but did not run freely along the mould. The ingot was hard to the file, and broke from a rude blow; though by gentle strokes it bore to be considerably flattened. Internally it appeared of a much duller and darker colour than silver, and of a coarser texture.

2. *One part* of platina and *two* of silver, covered with nitre and common salt, did not flow thin till the fire was raised to a very strong white heat. The compound proved less brittle than the foregoing, and not so hard to the file: The texture was composed of smaller grains, and the colour whiter.

3. *One part* of platina and *three* of silver still required a very strong fire for their perfect fusion: The metal was hard and brittle, though less so than the preceding: When well and repeatedly nealed, it bore to be hammered, or flattened betwixt steel rollers, into thin plates.

4. *One part* of platina and *seven* of silver melted together with ease. This compound hammered tolerably well, proved much harder than silver, and not so white, or of so fine a grain.

5. These

5. These compositions, weighed hydrostatically, turned out like the others, a little lighter than by calculation: But the difference, which before seemed to increase with the platina, was here greatest when the platina was in least proportion.

	Specific Gravity.		
	By Experiment.	By Calculation.	Difference.
Platina —	17. 000		
Platina 1, Silver 1	13. 535	13. 990	0. 455
Platina 1, Silver 2	12. 452	12. 987	0. 535
Platina 1, Silver 3	11. 790	12. 485	0. 695
Platina 1, Silver 7	10. 867	11. 732	0. 865
Silver —	10. 980		

Remark. Platina appears to unite more difficultly with silver than with either of the foregoing metals. Even when the proportion of the platina is small, the greatest part of it subsides upon an abatement of the heat, by which the union had been effected. This was prevented by pouring out the metal, when perfectly fluid, at one jet, into a broad mould; in which the compound began to congeal before the platina could separate.

Platina diminishes the malleability of silver far less than that of tin or lead; and does not, in whatever proportion employed, so much debase its colour, or dispose it to tarnish in the air.

A R T I C L E 4.

Platina *with* Gold.

1. *Equal parts* of platina and gold, exposed to an intense fire, melted perfectly together, and ran thin

thin into a long mould, without loss. The metal was of a white colour, hard to the file, broke from a rude blow, but when well nealed, yielded considerably to the hammer.

2. *One* part of platina and *four* of gold came into fusion in a moderate fire, but still required a very strong one for their perfect union. This compound appeared but a little paler than standard gold with *silver alloy*; and proved so tough, as to be beat, with proper care, into thin plates, without breaking or cracking about the edges. On melting it a second time with nitre and borax, it became very pale, and was not without great difficulty made to recover its colour.

A R T I C L E 5.

Platina *with* Copper.

1. *Equal parts* of platina and copper, exposed, without addition, to a strong fire hastily excited by bellows, soon became fluid, but not thin; and lost about one-sixty-fourth. The metal proved extremely hard to the file; broke difficultly on the anvil; flew asunder on endeavouring to cut it with a chissel; and appeared internally of a coarse-grained texture and white colour.

2. *One* ounce of platina and *two* of copper, urged with a quick fire in a blast furnace, without addition, flowed sufficiently thin, and scarce suffered any sensible loss. The metal was still very hard, and yielded but little to the hammer. It looked darker coloured than the foregoing, with a slight reddish cast.

3. *One* ounce of platina and *four* of copper, treated in the same manner, united, without loss, into a pretty

pretty tough compound ; which bore to be considerably flattened, cut with a chissel, and bent almost double before it cracked. Internally, it looked of a fine texture, and a very pale copper colour.

4. A mixture of *one* ounce of platina and *five* of copper, stretched somewhat more easily under the hammer than the preceding ; and appeared of a redder colour.

5. Upon increasing the copper to *eight* times the quantity of the platina, the compound proved sufficiently tough, broke difficultly, and hammered well. It was much harder than copper, and of a paler colour.

6. A mixture of *one* part of platina and *twelve* of copper was somewhat more easily extended under the hammer than the foregoing, and proved softer to the file. It stuck a little in the teeth of the file, which the compositions with a larger proportion of platina did not.

7. A mixture of *one* part of platina and *twenty-five* of copper was still a little paler coloured than pure copper, and considerably harder and stiffer, though very malleable. Upon increasing the copper a little farther, the mixture retained a degree of hardness, and appeared of a fine rose colour.

8. Upon weighing the foregoing compositions hydrostatically, the diminution of gravity was found more regular than in the mixtures with other metals, being constantly greater in proportion as the quantity of platina was larger.

		Specific Gravity.		
		By Experiment.	By Calculation.	Difference.
Platina	—	17. 000		
Platina 1, Copper	1	11. 400	12. 915	1. 515
Platina 1, Copper	2	10. 410	11. 553	1. 143
Platina 1, Copper	4	9. 908	10. 464	0. 556
Platina 1, Copper	5	9. 693	10. 191	0. 498
Platina 1, Copper	8	9. 300	9. 738	0. 438
Platina 1, Copper	12	9. 251	9. 458	0. 207
Platina 1, Copper	25	8. 970	9. 144	0. 174
Copper	—	8. 830		

Remark. In the foregoing fusions, though in general no flux was made use of, there was scarce any sensible loss of weight, unless in N^o 1, where the large proportion of platina required the fire to be raised to a violent degree. This seems owing, in good measure, to the platina preventing the scorification of the copper: For upon melting pure copper a great number of times, both with and without fluxes, there was constantly a little loss.

A small proportion of platina appears to improve the hardness of copper, without injuring its colour, or, so far as could be judged, its malleability. The mixtures with a large proportion of platina are difficultly extended under the hammer when cold; and whilst red hot, fly in pieces. They all bear a good polish, and do not tarnish in the air so much, or so soon, as pure copper.

A R T I C L E 6.

Platina with Iron.

Iron, the last of the metals in point of fusibility, was several times attempted to be united with platina,
in

in its perfect malleable state. But as the fluxes necessary for rendering forged iron fusible corroded the crucibles before the metal flowed thin enough to dissolve the platina, pure cast iron was substituted.

1. Cast iron and platina, of *each* three ounces, exposed without addition to a strong fire, united into a thick fluid; which, on adding an ounce more of iron, flowed thin. The compound suffered to cool in the crucible (which had become too soft from the heat to admit of its being poured out) was found, on breaking the vessel, in one lump, not convex, the form, which the iron usually assumes, but of a very concave surface: The weight about one-sixtieth less than that of the metals employed. It proved excessively hard, so as not to be touched by the file; and so tough, as not to be broke by repeated blows of a sledge-hammer, from which it received some impressiion. Heated red, it broke easily, and looked internally of an uniform texture, composed not of bright plates like the iron at first, but of very dark-coloured grains.

2. *One* ounce of platina being injected upon *four* of cast iron beginning to melt, and the fire kept up strong, the whole came quickly into fusion, and on cooling, formed an equable compound, which like the former proved extremely hard, and seemed to stretch a little under the great hammer without breaking. The colour was still very dark, though less so than when the platina was in larger proportion.

3. *One* part of platina and *twelve* of iron melted without difficulty, and with little or no loss. This compound was still much harder than the iron at first, and had a very considerable degree of tough-

ness. Like the others, it could not be broke whilst cold, without extreme violence ; but proved very brittle when heated red.

4. The foregoing compositions, especially those in which the proportion of platina was large, received a fine polish ; and did not rust or tarnish on being exposed to the air in a dry room for several months.

5. A composition of one part of platina and four of iron was treated with substances, which produce notable alterations in pure iron. Surrounded with Reaumur's steel-making mixture (composed of charcoal-powder, foot, wood-ashes, and common salt), and cemented in a close luted crucible for twelve hours, it gained an increase of one-thirty-ninth its weight, yielded to the file more easily than at first, seemed to receive no additional hardness on being ignited and quenched in water, and discovered none of the qualities of steel. A piece broke off from the same ingot, treated in the same manner, with the powder for softening cast iron (*viz.* bone-ash, with a small proportion of charcoal), was found increased in weight about one-thirty-fourth, proved less hard to the file than at first, but manifestly harder than the part cemented with the steel-making mixture.

	Specific Gravity.		
	By Experiment.	By Calculation.	Difference.
Platina —	17. 000		
Platina 3, Iron 4	9. 917	11. 343	1. 426
Platina 3, Iron 12	8. 700	9. 080	0. 380
Platina 3, Iron 16	8. 202	8. 663	0. 461
Platina 3, Iron 36	7. 800	7. 862	0. 062
Iron —	7. 100		

General Remarks.

Platina melts with equal its weight of each of the metals; with one more readily than with another. With some it becomes fluid, if the proportion of the platina is not large, in a moderate fire; but a strong one is constantly requisite for its perfect solution. Compositions of silver, copper, lead, with about one-third their weight of platina, which had flowed thin enough to run freely into the mould, and appeared to the eye perfectly mixed, on being digested in aqua fortis till the menstruum ceased to act, left several grains of platina in their original form. Upon viewing these with a microscope, some appeared to have suffered no alteration; others exhibited an infinite number of minute bright globular protuberances, as if they had just begun to melt.

Platina hardens and stiffens all the metals; one more than another, lead the most. In a moderate quantity it diminishes, and in a large one destroys, the toughness of all the malleable metals; but communicates some degree of this quality to cast iron. Tin bears much the least, and gold and silver the greatest quantity, without the loss of their malleability.

A very small proportion of platina scarce injures the colour of copper and gold: A larger renders both pale: A far less quantity has this effect upon copper than on gold. It debases and darkens, in proportion to its quantity, the colour of the white metals; that of silver much the least, and of lead the most. It in good measure preserves iron and copper from tarnishing in the air; scarce alters gold or silver in this respect; makes tin tarnish soon, and lead exceeding quickly.

P A P E R IV.

Platina *mixed with* Semi-metals.1. *With Mercury.*

Read July 4, 1754. I. **A**N ounce of platina and six ounces of pure quicksilver were rubbed together, with a little common salt and water, and a few drops of spirit of salt, in an iron mortar. After some hours trituration, the grains of platina became coated with the quicksilver, so as to cohere into an imperfect amalgam. A part of the fluid quicksilver, poured off, and evaporated in an iron ladle, left a considerable quantity of a dark-coloured powder, intermingled with bright shining *moleculæ*: A part strained through leather, left a smaller proportion of a similar powder.

The platina, which had been thus attenuated by the mercury, so as to pass with it through the pores of leather, proved as refractory in the fire as at first. Exposed to a very vehement heat, by itself, with borax, with white glass, it neither melted, or suffered any sensible alteration; nor did it communicate any colour to either of the fluxes.

2. One part of platina and about four of lead were melted perfectly together; and after the heat had somewhat abated, poured gently into three times the quantity of quicksilver, heated so as to fume. A blackish powder was immediately thrown to the surface: This appeared to be chiefly platina. On grinding them together, a fresh powder gradually separated; which, being occasionally washed off, in appearance

pearance greatly resembled the foregoing, but was found, on proper trials, to participate much more largely of the mercury and lead than of platina. The amalgam, which was of a very dull colour, on exposure to the fire swelled and leapt about, though the heat was scarce sufficient to evaporate the quick-silver. After constant and rapid agitation with water, occasionally renewed, in an iron mill, for a week, it looked bright and uniform, and suffered the mercury to exhale freely. A dark-coloured calx remained, which proved, upon examination, to be platina, with a very little lead.

Remark. Mercury is supposed to have a greater affinity with lead than any other metallic body, gold and silver excepted. In this experiment, it had a greater affinity with platina than with lead, since it retained most of the platina, after the lead, which was in much larger proportion, had been almost entirely thrown out. The part of the platina, which the mercury rejected at first, and that which it retained to the last, did not appear dissimilar to one another, or different in quality from the platina employed.

3. A mixture of one part of platina and two of gold, which proved very white and brittle, after being repeatedly nealed, was cautiously flattened into thin plates, and thrown red-hot into boiling quick-silver. On trituration and ablution with water, a powder separated, copiously at first, and by degrees more sparingly. After the process had been continued about twenty-four hours, there was no farther separation, except of a very little blackish matter, into which a part of the mercury is always changed in these kinds

kinds of operations. The amalgam, which looked very bright, left, upon evaporation, a spongy mass, of a high colour, which being melted, and poured into an ingot, proved very soft, extremely malleable, and in all respects resembled the pure gold made use of, without the least appearance of platina.

Remark. It is greatly to be wished, that this method of purifying gold from platina may prove sufficiently accurate to exactly determine the quantity of each in the mixt. The experiments hitherto made do not sufficiently clear up this point; a great number are still necessary before it can be fully ascertained.

2. *With Bismuth.*

Equal parts of platina and bismuth, injected into a mixture of black flux and common salt, previously brought into fusion, and urged with a quick fire, strongly excited by bellows, melted perfectly in a few minutes, and suffered very little loss. Without these precautions, the bismuth could scarce be made to take up above one-third its weight; great part of which, on an abatement of the heat, subsided.

Mixtures of platina with different proportions of bismuth proved all, like the bismuth itself, extremely brittle: One was not remarkably more so than another. To the file, they were scarce harder than pure bismuth. They broke of an irregular surface, composed chiefly of striæ, with some plates. When newly broken, they looked bright and sparkling; except the compositions with a large proportion of platina, which were of a dull greyish colour, without any brightness. They all tarnished slowly in the
air,

air, to a dark yellowish, purplish or bluish colour: Several acquired in part a fine deep blue, which has suffered no change in above a twelve-month; some parts of the masses still remaining white as at first, and others inclining to purple.

3. *With Zinc.*

Upon an ounce of platina, covered with borax, and heated in a blast furnace to a strong white heat, was injected an equal quantity of zinc. A violent deflagration arose, and the platina was almost instantly dissolved: The matter, immediately poured out, was found to have lost near half an ounce.

Upon several times repeating this experiment with different proportions of the two metals, both in a quick fire, and in one more gradually raised in a wind furnace, the zinc was constantly found a powerful menstruum for platina, but suffered great loss from the heat requisite for rendering the mixture sufficiently fluid. When so much of the zinc had been dissipated, that the remainder amounted to no more than one-fourth of the platina, the compound still continued fluid enough to run freely into a long mould.

Compositions of platina and zinc differed little in appearance from zinc itself; except that where the quantity of platina was large, they were of a closer texture, and a duller hue, with rather more of a bluish cast. They did not tarnish, or change their colour, on being exposed for several months to the air, in a dry room. They were harder to the file than the zinc at first, and fell in pieces under the
hammer;

hammer, without at all stretching; which pure zinc does in a considerable degree.

4. *With* Regulus of Antimony.

Regulus of antimony, the most difficultly fusible of the semi-metals, dissolved, in a strong fire, equal its weight of platina. The compound looked of a much duller colour than the regulus at first; and broke of a close and uniform, though uneven, surface. It proved considerably harder to the file, but not remarkably more or less brittle.

On increasing the quantity of the regulus, the compound proved brighter, and of a leafy texture, little different from that of the pure regulus.

Platina *mixed with* Compound Metals.

1. *With* Brass.

1. Equal parts of platina and brass, covered with borax, and urged with a quick fire in a blast furnace, melted perfectly together, and scarce suffered any loss. The mixt was of a greyish white colour, filed hard like bell-metal, broke from a blow of the hammer, without stretching or receiving any impression, and flew asunder on endeavouring to cut it with a chissel. Internally, it appeared of an uniform fine grain, a close texture, and a darker colour than on the outside. It bore a very fine polish, and did not tarnish on being exposed to the air in a dry room for many months.

2. One part of platina and two of brass, melted in a slow fire, lost about one-thirty-sixth. The ingot was of a duller colour than the foregoing, with
a faint

a faint yellowish cast : It filed softer, broke less readily from the chissel, but cracked and fell in pieces under the hammer.

3. One part of platina and four of brass, covered as before with borax, and exposed to a quick fire, melted without loss. This compound proved yellower than the preceding, filed softer, bore to be cut some depth with a chissel before it broke, and received some impression from the hammer, stretching a little, but soon cracking in various directions.

4. Upon increasing the brass to six times the weight of the platina, the compound appeared yellower, though still very pale. It proved softer to the file ; and received a greater impression from the hammer, and a deeper one from the chissel, before it broke.

5. A mixture of one part of platina and twelve of brass was considerably paler, and much harder, than brass. It broke from the chissel ; and cracked, before it had extended much, under the hammer. It bore a good polish, and was less apt to tarnish than brass ; though in both respects it fell short of the compositions with larger proportions of platina.

2. *With Copper and Tin.*

1. One hundred parts of platina, thirty-four of copper, and twelve of tin, covered with borax, became fluid in a strong fire, and suffered no considerable loss. The ingot proved extremely hard, so as scarce to be touched by the file ; and very brittle, breaking from a moderate blow, of a rough surface, and dull bell-metal colour. It bore a good polish, and did not tarnish in the air.

2. Platina and copper, of each one ounce, and four ounces of tin, melted perfectly together, and without loss. This compound filed freely and easily, bore to be cut with a knife, but broke readily on the anvil, of an irregular surface, and dull whitish colour. Polished, it looked like polished iron. The fracture soon tarnished to a yellow; the polished part grew dull, but retained its colour.

3. A mixture of platina and copper, of each one part, and eight of tin, proved softer than the foregoing; and bore to be flattened a little under the hammer. It broke of a very irregular surface, composed of a great number of bright white plates. The fracture soon tarnished; the polished part retained its colour.

Remark. It is observable, that in the first of these experiments, platina was perfectly taken up by less than half its weight of a mixture of copper and tin; though it could scarce be made to melt with less than its own weight of either of them separately, in a fire equally, or rather more, intense.

The specific gravity of these mixtures turned out, upon experiment, a little less than by calculation; though the copper and tin, melted together without platina, formed a compound specifically heavier than even the copper by itself.

The several mixtures with zinc, bismuth, regulus of antimony and brass, were likewise weighed hydrostatically, and found all somewhat lighter than they ought to have been by calculation. As few hydrostatical experiments seem to have been made upon zinc and bismuth, it may be proper to mention, that

that the gravity of pure zinc turned out 7. 050, and that of bismuth 9. 733.

Hitherto we have considered the miscibility of platina with metallic bodies, and the alterations, which different proportions of it produce in their appearance and qualities: employing the necessary precautions for preventing the scorification and dissipation, which most of the metals suffer in the fire; and which some remarkably promote in those, which by themselves are more difficultly, or not at all, destructible. We shall now examine the relation of platina, in this respect, to those metallic substances, which are the most destructive.

1. *Cupellation and Scorification of Lead with Platina.*

1. A mixture of platina and lead was cupelled, under a muffle, in an assay-furnace. For some time the process went on well; the lead gradually changing into scoriæ, which were thrown off to the sides, and absorbed by the cupel, or dissipated in fume. In proportion as the lead worked off, the matter required a stronger fire to keep it fluid; and at length, collecting into a dull flat lump, could no longer be made to flow in the greatest degree of heat, which the furnace was capable of giving. The lump broke very easily, appeared of a dull grey colour both internally and externally, and of a porous texture. It weighed about one-fifth more than the quantity of platina employed.

2. This experiment was many times repeated and varied: the lead attempted to be worked off on bone-ash, pressed into the bottoms of crucibles, sco-

rified in assay-crucibles, by intense fires, in a blast furnace, and blown off on tests before the nose of a bellows, with the same event; the platina not only perfectly resisting the power of lead, which by these operations destroys every other known metallic body, except gold and silver, but likewise retaining and preventing the scorification of a part of the lead itself.

3. In the history of the fusion of platina with lead, it has been observed, that this metal deposits in a gentle heat great part of the platina, which had been united with it by a strong one. As the part, which remained suspended, might be presumed to differ from that, which subsided; a quantity of lead was decanted off from fresh parcels of platina, and both the decanted metal and the residuum submitted to the preceding operations separately. The event was still the same; the matter becoming consistent, when the lead had been worked off to a certain point, and refusing farther scorification.

4. A mixture of platina and lead, which had been cupelled in an assay-furnace as long as it could be kept fluid, was exposed in a crucible to a fire vehemently excited, by itself, with powdered charcoal, with black flux, borax, nitre, common salt. The matter neither melted, or suffered any considerable alteration, becoming only somewhat more porous; probably from a little of the lead having exsuded without the liquefaction of the mass. The immediate contact of burning fuel, agitated by bellows, made some of these mixtures flow, after they had refused to melt in vessels acted upon by intense fires. Very little of the lead was dissipated by this means.

5. Upon

5. Upon examining the cupelled matters hydrostatically, those, which appeared most spongy, were found nearly as ponderous as the crude platina. Among the more compact, the gravity of one turned out 19.083; of another 19.136, and of a third 19.240.

Remark. It appears from these experiments, that platina, like gold and silver, is intirely indestructible by lead; that probably the purer grains, or fragments, have some heterogeneous admixtures, which are separated in these operations; and that, perfectly pure, it is more ponderous than gold, since, when mixed with a considerable proportion of a lighter metal, it fell very little short of the gravity of pure gold. There is no reason to suspect any increase of its specific gravity from the mixture; since in all the compositions with platina hitherto examined, there was constantly a diminution of the specific gravity; whether the proportion of the platina was large or small, the matter melted with a quick fire, or kept in fusion for many hours.

6. A mixture of one part of platina and three of gold was cupelled with lead, under a muffle. The matter drove well for a considerable time; at length collected into a bright hemispherical lump, which by degrees became flatter, dull, and rough. The button, on being weighed, was found to retain a considerable portion of lead.

The experiment being repeated with a mixture of one part of platina and six of gold, some part of the lead was still retained. The bead proved rounder and brighter than the foregoing, and of a good golden colour on the outside: It broke easily under the hammer, and appeared internally greyish: Some of the
fragments

fragments hung together by the outward golden coat.

7. Mixtures of platina and silver, submitted to cupellation, retained likewise a considerable quantity of the lead. These, in becoming consistent, formed, not an hemispherical bead, but a flat mass, very rough, and brittle, and of a dull grey colour both internally and externally.

2. *Cupellation and Scorification of Bismuth with Platina.*

Mixtures of platina with bismuth, a metallic substance, in some respects more active than lead, were cupelled under a muffle, scorified in assay-crucibles, tested before the nose of a bellows. In numerous repetitions of these experiments, the event was the same, as when lead was made use of. The mixtures, which at first flowed easily, became less and less fusible, in proportion as the bismuth was driven off; and at length could not be kept fluid in an intense white heat, though they appeared, on weighing, to retain a considerable proportion of the bismuth. Nor could this semi-metal, any more than lead, be entirely separated, by cupellation, from mixtures of platina with either gold or silver.

Platina cupelled with bismuth, differed little in appearance from that, which had been treated in the same manner with lead. The button was more spongy, and specifically lighter.

3. *Diffusion of Regulus of Antimony with Platina.*

A mixture of platina and regulus of antimony was melted, by a strong fire, in a shallow wide crucible,
and

and the nose of a bellows-directed obliquely upon the surface. The matter continued to flow, and fume copiously, for some hours; at length became consistent in an intense white heat, and scarce emitted any more fumes, though strongly blown on. The mass, when grown cold, broke easily, appeared very porous, blebby, of a dull grey colour, and weighed considerably more than the quantity of platina employed.

Platina was likewise treated with crude antimony; and the regulus, obtained from this mixture, diffused as the foregoing, with the same event; the platina not only resisting the antimonial semi-metal, but likewise defending a part of it from the action of the fire and air, and refusing to melt, after a certain quantity had been diffipated.

4. *Deflagration of Zinc with Platina.*

A mixture of platina and zinc, exposed to a strong fire, deflagrated, and appeared in violent agitation. This continued but a little time; the matter quickly became solid, and could no longer be made to flow; or the zinc, of which a considerable proportion remained in it, to flame. The mass was very brittle, dull-coloured, spongy, and of no specific gravity.

General Remarks.

This extraordinary mineral, on which the most active fluxes, assisted by the most intense fires, have no effect, melts perfectly with all the known metallic bodies; unless arsenic, a substance impatient of a degree of heat sufficient to render itself fluid, is an exception. All the metals take up equal their own weight;

weight; some metallic compositions more than twice their weight.

Platina appears in general to have no remarkable affinity with one metal more than with another. Lead and iron, which do not mingle together, and of which the former will take up some bodies from the latter, and the latter some from the former, seem both indifferent to platina; which, if combined with either, is not separated by the other.

Nevertheless some substances have greater or less degrees of affinity with platina than with other metallic bodies. Thus, from aqua regia, in certain circumstances, it throws out gold; and is itself precipitated by the other metals, which dissolve in that menstruum. From quicksilver it throws out lead; and is itself thrown out by gold.

The changes, which platina occasions in the perfect metals, were examined in a former paper: Its effects on the semi-metals are less remarkable. The principal are, that it increases the hardness of zinc, and the antimonial semi-metal, but not of bismuth; and disposes this last to change its colour in the air, but not the others.

Its effects on the compound metals are similar to those, which it produces on the simple ones. Brass it renders white, hard, brittle, susceptible of a fine polish, and not liable to tarnish in the air, as it does the copper, and in some degree the zinc, of which this metal is composed. Mixtures of it with copper and tin are more apt to tarnish than with copper only, and less than with tin only.

All metallic substances, except gold, are exuded from platina by the simple acids: Mercury is the only

one separable by fire. The platina remaining after the separation of the metals, proves unfusible as at first.

Platina perfectly resists the destructive power of lead and bismuth, and the rapacious antimonial semi-metal; which last has been hitherto esteemed the severest test of gold, so as to have received the appellation of *balneum solius solis*, the bath which gold alone can sustain, and in which it is washed from all kinds of impurities.

Since therefore platina mixed with gold is not discoverable by any of the operations by which that metal is usually assayed or refined, or by the hydrostatic balance; we hope that these papers, which contain part of the history of this extraordinary and hitherto unknown mineral, and the methods of distinguishing any sophistications of gold made by its means, which might otherwise have passed undiscovered, will be candidly received by this illustrious body, as a means of promoting that kind of knowledge, for which the Royal Society has been ever eminent, and peculiarly instituted.