tion only, for the colour fades rapidly in sunlight, and is easily washed out by soap and water. Substances similar to eosine, which have even still more recently appeared in trade, are called coccine and nopaline; they yield beautiful but perishable red colours on wool and silk.

Red colours on cotton.—Turkey red.—Cochineal, which is so suitable a colouring matter for wool, does not dye satisfactory colours upon vegetable fibres; but from very remote times the Hindus have possessed a process for dyeing a brilliant and extremely permanent red upon cotton fabrics by means of madder. This process travelled westward through the Levant into Turkey and Greece, the date of its introduction into Western Europe going no further back than the middle of the 18th century, at which period Greek dyers were induced to settle in France and make known the methods in use for the production of this much desired colour. The name Turkey red, or Adrianople red, was applied to calico dyed with it at the time that such goods could be obtained only from the East, and it still retains the name. So much was the colour esteemed that in 1765 the French Government circulated a pamphlet describing the best known methods of dyeing it on yarns, and some years afterwards, the British Government paid a sum of money to a Frenchman named Papillon, for disclosing the whole process of obtaining it. The dyeing of Turkey red upon cloth and yarn is now extensively carried on in Great Britain, and with great success. Turkey red is essentially a madder red with an aluminous basis, but differs from a common madder red by containing oil, and it is the fixing and combining of the oil with the fibre and the colour which constitutes its peculiarity. Divested of details the process of producing Turkey red may be divided into four stages:—(1) the oiling of the cloth; (2) mordanting with a salt of aluminium; (3) dyeing with madder, or its equivalents garancin or alizarin; and (4) the brightening of the dyed colour. The preparation of the cloth with oil is a process used in no other kind of dyeing; of its utility there can be no doubt, but all the attempts of chemists to explain the *rationale* of its action have failed. There are many modifications of the method of applying the oil, but the older and more commonly used process is to mix the oil with a dilute solution of potash or soda ash, so as to diffuse it uniformly through the liquid, forming an emulsion; the oil is not dissolved by the alkalies, nor is it supposed to combine with them, but is simply held in a state of excessively fine mechanical division. A low quality of olive oil is most generally used in Europe, that from Mogador, in the north of Africa, being very suitable. Certain kinds of oil do not answer for Turkey red, only those being suitable which, probably from containing free fatty acids or aluminous matters, readily form a milky emulsion with weak alkaline solutions; other kinds are, however, in use in some places. The cloth to be dyed is steeped in the oily emulsion, wrung out, and dried in a warm stove; this process is repeated six or eight times, and the cloth is finally washed in weak alkali to remove from it all the oil not intimately united to the fibre. The result of this treatment, which is the most delicate and important in the Turkey red process, is that the cloth becomes impregnated with a fatty matter, which by the contact of alkalies and heated air has undergone some change from its original state, which is usually called an oxidation, but the nature of which is really unknown. The cloth now possesses a power of attraction for mordants and colouring matters greatly superior to untreated cloth; and further, its physical condition is changed so that colours upon it are more transparent and more vivid than upon ordinary cotton.

The cloth in this state is ready for mordanting, which is done by passing it through a bath of alum, partly neutralized with carbonate of soda or by chalk, or in a bath of acetate of alumina, the object being to obtain a regular deposition of the aluminous base upon the fibre; the excess of mordant is carefully washed away from the cloth, which is now ready for dyeing.

The dyeing is accomplished in the ordinary way, by keeping the cloth in continual motion in a vessel containing heated water and the dye stuff, which may be madder, garancin, or artificial alizarin. It is a very general practice to add a quantity of ox-blood to the water used in dyeing Turkey red. What purpose this fulfils is not known; its colouring matter cannot be supposed to be of any use; its albuminous constituents may have some useful action, but this seems very doubtful; probably its addition is quite superfluous, and is retained from older times, when dyeing was less understood than at present. When the dyeing is completed the colour is a full and deep but dull red, which requires brightening. The brightening operations consist in removing brownish matters from the dye by boiling in soap and alkalies. To give a still more brilliant colour, the goods are boiled for several hours in a closed copper boiler with a mixture of salt of tin with the soap used in the last process of brightening,—occasionally under a pressure greater than that of the atmosphere, in order to obtain a temperature some degrees higher than 212° F.

In many processes of Turkey red dyeing, the cloth is treated with decoction of gall-nuts, or with sumach, after the preparation with oil and before the mordanting; this enables it more easily to absorb and fix the aluminous mordant, but it is not essential, and is most generally omitted.

No allusion has been made to a number of excrementitious and other animal matters, which the old dyers used in the oiling process, such as sheep-dung, cow-dung, ox-bile, &c.; they can be dispensed with, and were employed probably from caprice and ignorance.

Barwood red.—An imitation of Turkey red is obtained from barwood; it is much inferior both in beauty and stability to the real colour, but the ease with which it can be dyed, and the less costly nature of the materials employed, enable it to be sold at a much lower price, and for some purposes it is largely used. Barwood is one of the red dye-stuffs of which the colouring matter is very slightly soluble in water; it is used in a state of fine powder. The cotton to be dyed is impregnated with a tin mordant by any of the means known to dyers, and then boiled with the dye-stuff; the colouring matter as it dissolves is fixed by the mordant, and the process is continued until the required shade is obtained. This wood, and a similar material called camwood, are also employed in woollen dyeing to give brownish reds, and to dye a "bottom" or foundation for indigo blue colours, by which some economy in indigo is effected, and a peculiar bloom on the blue is produced.

The class of woods represented by Brazil wood. do not yield good reds upon cotton.

Blue Colours.

The most important of the blue colouring matters is indigo. This may be said indeed to be the most important of all colouring matters, both as regards the large quantity and monetary value of what is produced and sold, and the permanence and solidity of the dyed colours which it yields. The indigo dye is a manufactured article, prepared in the place of growth of the plant which produces it. The indigo plant could itself be used for dyeing, but from 200 to 250 lb of it would be required to produce the effect of a single pound of the prepared indigo. In England, and many other countries possessing a temperate climate, the species *Isatis tinctoria*, or woad, has been cultivated, and has been used from time immemorial for dyeing blue. Its comparative poverty in colouring matter has caused it long since to be disused by dyers as a source of colour; it is, however, employed by them in the preparation of their indigo vats, but rather as a convenient material to induce fermentation than as a dye.

Indigo is distinguished from nearly all other colouring matters by its complete insolubility *per se* in water and other ordinary solvents. It dissolves to a very slight extent in heated aniline, petroleum, and acetic acid, which upon cooling redeposit it; the only real solvent for it is anhydrous acetic acid mixed with a little sulphuric acid, from which water precipitates it unchanged, but this solvent is inapplicable in dyeing. But solubility is an essential condition for dyeing, and means have been found to obtain satisfactory solutions of indigo by circuitous methods which involve the temporary destruction of its blue colour and a change in its chemical composition. By various deoxidizing agents, indigo blue can be changed into a white substance, indigo white, which dissolves with facility in all alkaline liquids, forming a colourless or slightly yellow solution. On exposure to the air or other sources of oxygen, the solution yields the insoluble blue indigo, and permanently dyes any fibre which has been saturated with it.

This is the only case in which such a method of dyeing is applicable, and on that account it possesses much interest. We shall now proceed to describe some of the practical methods in use for indigo dyeing.

Fermentation process.—The oldest of these, and one naturally suggested by the method employed in preparing the dye-stuff, is the process of fermentation in contact with lime, or sometimes soda or potash. During this process, gaseous or liquid substances are formed, which have the power of reducing indigo from the blue to the white state, and fitting it for dyeing. This ancient method has not been superseded in England at least, being employed at the present day for nearly all woollen goods dyed with indigo, the consumption of which is greater for woollen than for all other kinds of cloth.

The woad vat.—To a course of lectures upon dyeing, recently delivered by Mr Jarmain before the Society of Arts, we are indebted for the substance of the following account of the woad vat used by the Yorkshire dyers. The materials employed are indigo, woad, madder, bran, and lime. For this process as for every other in which it is employed, the indigo must be reduced to the finest possible powder. It is generally ground mixed with water, in closed revolving cast-iron cylinders containing iron rollers or balls, for several days, or until the slime or pulp formed contains no visible particles of the dye-stuff. The proportions of materials employed are:

Lincolnshire woad	5 cwt
Wheaten bran	18 lb.
Slaked lime in dry powder	22 "
Madder	2½ "
Indigo	24 "

The woad is first placed in the dyeing vat nearly filled with water, which is heated to between 140° and 150° F.; after some hours (required to soften the woad), the bran, madder, and indigo are added, and half of the whole quantity of lime. In a few hours, if all is right, signs of commotion produced by fermentation will be visible, the liquid will become greenish, and a blue scum will be visible on the surface; a piece of wool is put in as a test, and if in a short time it becomes dyed blue the process is proceeding well; a little more lime is added, but at intervals, so as not to check the progressing fermentation, and, if it should become necessary, the vat is heated up by steam to its original temperature; on the third day the vat should be ready for dyeing. Such a vat as this requires skilful management to control the fermentation; without lime the reduced indigo would not be dissolved; with too much lime the fermentation would be stopped. The woad acts as an easily fermentable matter, and furnishes a portion of blue colour; the bran also no doubt is useful, on account of the ease with which it begins and promotes fermentation; the madder is probably of no use at all, its employment being still continued from an old unfounded notion that it gives some of its red colouring matter to the indigo-dyed goods, for the small amount of saccharine matter present in 2½ lb of madder cannot be held of any importance in the presence of 5 cwt. of woad.

A woad vat, when ready for dyeing, consists of a certain depth of a tolerably clear solution of white indigo in lime, and a somewhat voluminous semi-solid mass at the bottom, consisting of the bulk of the woad, the excess of the lime, the insoluble part of the madder, and the impurities always present in indigo. To keep the cloth to be dyed from contact with the muddy bottoms an iron hoop, of the internal diameter of the vat, covered with a network of open meshes is lowered into it and secured at a safe distance from the bottom.

The pieces to be dyed, after being well cleansed, are placed in the liquor, and kept in constant movement to insure full access of the colour to all parts. The time required to dye, varying from 20 minutes to two hours, will depend upon the fineness and weight of the cloth, and upon the depth of colour required; if the goods require it, they are dyed a second time. In moving the pieces about, they must not be brought above the surface of the liquid, for the oxygen of the air would restore the dissolved white indigo to its blue insoluble state. When the pieces are found to be sufficiently impregnated with the dye, they are withdrawn from the vat; at the moment of leaving the dyeing liquor they are seen to be of a yellowish colour, which almost instantly changes into a bright green, then darker green, and finally becomes blue through the absorption of oxygen by the white indigo. Loose wool or yarn is dyed by inclosing it in an open and movable network bag.

The vat above described can of course dye only a limited quantity of material, becoming after every operation poorer in indigo; but it is not necessary to re-set a vat. The strength of its contents is kept up by constant additions of indigo, lime, and bran; no more woad is added, the quantity used at first being sufficient for about its own weight of indigo.

Bran and molasses vat.—Another kind of indigo dye vat, very extensively used on the Continent, and highly spoken of by practical men, is prepared as follows. A vat 6 feet in diameter and 7 feet deep is filled with water warmed to 130° F.; then 4½ lb of ground indigo, 34 lb crystals of soda (or instead 16 lb soda ash) and 67 lb of bran, and twelve hours afterwards 2 lb slacked lime, are added; in 24 hours the indigo should commence to be dissolved, and a test strip of stuff plunged in the liquid should be speedily dyed, but some hours longer and the gradual addition of 18 or 20 lb more of lime are required to bring the liquor into its best condition. In this vat, as in the woad vat, the lime controls the fermentation of the bran, and has to be added with care. With each pound of indigo added to replace what has been removed from the vat during a day's dyeing ½ lb of molasses and ½ lb crystals of soda and 3 or 4 lb lime must be used. By daily replenishing the vat it can be used continually for four or five months; at the expiration of that time the bottoms must be removed; the supernatant liquor containing indigo in solution may be used instead of water for setting a fresh vat. This vat is said to have quite supplanted the old woad and madder vat, molasses being preferable on the score of cheapness and also of solubility. The soda not being necessary for the solution of the indigo could be omitted in the setting of the vat, but it is reckoned useful in assisting the wool to take the dye; for the wool, however well it be bleached, is said to retain some greasy matters that yield to the soda, which thus enables the indigo to give fuller and faster colours than when lime alone is used.

It is to be observed that the two vats just described are what are distinguished as "warm vats," being made and worked at a temperature considerably above that of the air,—a condition held necessary for dyeing wool and some kinds of heavy cotton goods. For ordinary cotton dyeing the vats are used cold or at the ordinary temperature of the air, and are prepared in quite a different manner.

Copperas and lime vat.—A strong copperas and lime vat is composed as follows:—

900 gallons of water.
60 lb green copperas
36 lb ground indigo.
80 to 90 lb dry slaked lime.

These materials are well mixed together and raked up at intervals for say 24 hours, when the vat is ready for use. The lime decomposes the salt, liberating ferrous oxide, which acts upon the indigo, converting it into white indigo, which dissolves in the lime water. In large establishments for dyeing calico blue, it is usual to have a series of such vats in a row; the pieces to be dyed are tightly stretched on a frame and dipped in the liquid for from seven to ten minutes, after which they are believed to be as fully saturated as possible; the frames are next raised into the air, and in a few minutes the blue colour becomes developed; the same process is then repeated until the required depth of colour is obtained. By printing certain resisting compositions on the cloth previous to the dipping, white figures can be obtained upon a blue ground, producing what is known as the navy-blue style of print, formerly much worn by the lower classes in England. By combining suitable mordants with the resisting composition, not only white, but orange, yellow, and green coloured figures can be obtained upon the blue ground; but the production of these is rather a branch of calico printing than of dyeing proper.

Although this kind of vat is most generally used for the lighter qualities of calicoes, it can also be applied to such woollen goods as merinoes, which are not very closely woven, and also to silks.

Hydrosulphite of soda vat.—In 1871 Schützenberger and Lalande introduced a new reducing agent applicable to indigo dyeing, the so-called hydrosulphite of soda, obtained by acting upon acid sulphite of soda with metallic zinc. It possesses the most energetic deoxidizing powers, and in the presence of alkalies almost immediately reduces and dissolves indigo. It has been applied both in dyeing and in printing indigo colours, but cannot be said to have succeeded in displacing the older kinds of vats, having the disadvantage of costing much more without producing any apparent improvement in the colour yielded.

By preparing a very strong indigo vat, and thickening the fluid with gum, it is possible to print indigo blue colours in designs, but the many difficulties attending the process have very much restricted its application.

The colour yielded by indigo, though far from brilliant, is extraordinarily permanent, and is much used for articles intended to withstand much wear and rough usage, and also as a basis for the best quality of black upon fine woollen cloth.

Sulphate of indigo.—When indigo is acted upon by concentrated sulphuric acid it forms a solution of the so-called sulphate or extract of indigo, which, though possessing an intensely blue colour, cannot by any means be made to furnish the original dye. This preparation of indigo is applied only in wool and silk dyeing; it gives blues which are tolerably bright, but possess none of the stability of those obtained from real indigo. For vegetable fibre it has no affinity whatever either with or without mordants.

Prussian blue.—This, perhaps the earliest of artificial dye-stuffs, was accidentally discovered in 1710, though not used in dyeing for some time afterwards. The simplest method of employing it consists in first impregnating the material to be dyed with peroxide of iron, and then passing it into a solution of yellow prussiate of potash acidified slightly with sulphuric acid. Prussian blue upon silks is thus dyed. The most convenient way of obtaining a deposit of the oxide of iron consists in soaking the silk in a somewhat strong solution of the ordinary dyers' nitrate of iron; in the course of two or three hours a certain quantity of the oxide is found to be intimately combined with the silk; the excess of nitrate is then washed away and the silk worked in the acidified prussiate bath, when it immediately assumes a light azure shade; by repeating the treatment several times any depth of colour may be obtained.

Calico can be dyed in the same way, but both for that and for silk it is usual to add to the iron solution a small quantity of salt of tin, which is useful in giving a purplish tone to the blue and preventing the production of a disagreeable greenish tinge.

A deep colour cannot in this way be satisfactorily given to woollen, for which a treatment is adopted depending upon a decomposition of the prussiate by means of heat and acids. For dyeing say 110 lb of merino the following proportions and methods may be used. Dissolve 9 lb of yellow prussiate of potash in hot water, and add the solution to the required quantity of water; then add 14 lb sulphuric acid, 6 lb sal-ammoniac, and about 6 oz. of crystals of protochloride of tin; the merino is placed in the mixture, and the temperature of the dye-bath gradually raised to the boiling point in five hours. The blue gradually formed on the cloth requires brightening in a fresh bath consisting of alum, persalt of tin, and cream of tartar, heated to nearly the boiling point. Red prussiate of potash is used in nearly the same way to dye dark Prussian blues upon wool, but as it is more easily decomposed than the yellow prussiate a weaker acid-bath suffices. These blues are frequently finished off with logwood to give them a deeper tone.

Prussian blues can also be obtained on such woollen goods as merinoes, by a process of padding, and the use of a colour nearly identical with the so-called French or royal blue used by calico printers. A mixture is prepared as follows. Half a pound of wheaten starch is boiled with about half a gallon of water; in the thin paste thus made 13 oz. of powdered yellow prussiate are dissolved, and afterwards 6 oz. of tartaric acid; when the mixture is quite cold 1 lb of prussiate of tin in paste is added, 1½ oz. oxalic acid, and 3 oz. sulphuric acid; the whole is well mixed and strained. The woollens to be treated are first "prepared," as it is called, by impregnating them uniformly with oxide of tin, and then the above thickened mixture is applied by means of rollers, so that it shall be evenly and smoothly spread over the whole stuff; the cloth is then dried and exposed to the action of steam, which causes the acids to react upon the prussiates, and from a nearly colourless mixture develops an intense blue, which is found to be permanently fixed in the fibre.

Aniline blues.—There are several artificial blue dyes made from aniline and similar bodies, which yield very brilliant colours on wool and silk. They can be easily applied, the goods simply requiring to be worked in their aqueous solution until they have acquired a sufficiently dark tinge. An artificial dye called Nicholson's blue is differently applied; it is dissolved in an alkaline liquid, and forms then a colourless or nearly colourless solution, with which the goods to be dyed are impregnated; they are then passed into dilute acids, which develop the blue colour.

Litmus and logwood blues.—The other substances which have been used for blue colours, such, for example, as litmus, are of little importance, and are now nearly unknown to the practical dyer. A blue can be obtained from logwood which has some resemblance to indigo blue upon wool, but it is of a very low character both as to stability and shade, and is hardly ever employed by respectable dyers.

Yellow Colours.

Yellow textiles, being less pleasing to the eye, and more readily soiled, are not nearly so much in use as those dyed with the two simple colours blue and red. The chief yellow dyes, besides fustic, are quercitron bark or its concentrated extract flavine, Avignon or Persian berries, and the now almost disused indigenous product, weld. The general mordant for these is tin, sometimes with addition of alum. One or two illustrations will suffice to show the methods of using them.

Fustic yellow.—Fustic is probably the most generally employed yellow dye-stuff for wool; it gives yellows inclined to orange. For light shades it is not necessary to mordant the wool: it is simply well cleansed, and then heated with fustic decoction and some cream of tartar. For darker shades the wool is boiled with solution of tin and tartar, washed, and then worked in the decoction of fustic.

Picric acid yellow.—Picric acid, one of the artificial colouring matters, gives pure though not deep yellow shades upon silk and wool without the aid of a mordant, the cleansed material being dyed by working it in a warm solution of the acid.

Chromate of lead yellow.—The yellow most commonly employed for cotton goods is obtained by the use of salts of lead and bichromate of potash. The method of obtaining this colour differs somewhat from any previously described. The cotton, having been properly bleached, is impregnated with a salt of lead, usually by employing a solution of the acetate or sub-acetate of lead. The goods are next passed into a milk of lime solution, to which it is prudent to add some acetate of lead, in order to prevent the lime from dissolving the oxide of lead at first precipitated; the result of the lime treatment is that oxide of lead is evenly fixed upon the cotton, the excess of lime and lead is then well washed away, and the goods are passed into a solution of bichromate of potash, where they quickly acquire a bright and deep yellow colour, owing to the formation of the well-known pigment chrome yellow. To facilitate the combination, the bichromate of potash is mixed with as much sulphuric acid as suffices to liberate the whole of its chromium as chromic acid. The yellow-dyed goods require no further treatment than a good washing, the colour being quite fast. This yellow is, however, in very little demand, and in ninety-nine cases out of a hundred it is immediately converted into an orange, by passing it through boiling lime-water, which produces the basic chromate known as chrome orange, which has alway been in demand for many articles of wear.

Compound Colours.

The so-called simple colours—red, blue, and yellow—having now been dealt with, it remains to treat of their combinations, and this may be done briefly, the processes employed being for the most part similar to those already described. The compound shades in Chevreul's chromatic nomenclature amount to nearly 15,000, and it is very probable that fully that number are produced by the dyers of the present day. For practical treatment, however, the compound colours can be reduced to comparatively few classes. Mixing the simple colours one and one we obtain three compound colours,—blue and yellow give green, blue and red give purple, yellow and red give orange; while there may be a normal green, purple, and orange, it is evident that all the varieties of these several colours will depend upon the proportions of their constituents. If the three simple colours be mixed together, say in equal proportions, we may get a normal brown, or even a black; but if in unequal proportions, an immense number of shades, varying from the imagined normal brown to grey and drab, are produced. Although in many cases compound shades are produced by means of two or more simple colours, there are many natural as well as artificial dye stuffs which yield them ready formed, and frequently purer than they can be otherwise obtained. Most of these will be found mentioned in the following brief notice of practical processes in use.

GREEN COLOURS.

Lo-kao or Chinese green.—Until about the middle of the present century there was not an instance known of any green on textiles which was not composed of the two separate colours blue and yellow. About that time some green-dyed cottons, imported into France from China, attracted the attention of chemists, who were surprised that they could not separate the green into blue and yellow constituents. Inquiries showed that the Chinese employed a green colouring matter called Lo-kao, until then unknown in Europe. It was a costly dye-stuff, selling in China for its weight of silver. Some quantity of it was imported and used in silk-dyeing by the French: it was not, however, found altogether satisfactory, and has at length been quite abandoned for the aniline greens, which are in every respect preferable.

Aniline green.—There are two or three kinds of artificial green dyes in use, of which that known as methyl-aniline green, applied in silk dyeing, is most in request. The so-called iodine green has also been somewhat extensively employed for all kinds of fabrics.

These artificial and unstable materials are the only dye-stuffs for green possessed by the dyer, who is compelled to produce the colour by means of blue and yellow elements. The arsenical mineral green and the oxide of chromium green may be just mentioned as of extremely limited employ. The blues used in dyeing green are indigo, Prussian blue, and the sulphate of indigo. The yellows are afforded by Persian berries, quercitron, fustic, or the yellow chromate of lead. The processes employed consist, for the most part, in the separate application of the blue and yellow; for example, in dyeing a fast green upon wool from indigo and any of the yellow dye-stuffs, the blue is first produced as previously described, and the proper mordant for the yellow is then applied to the cloth, which is afterwards placed in the yellow colouring matter; the two colours are so intimately mixed as to be indistinguishable even by high magnifying powers. It may be observed that the reception of the blue does not to any perceptible extent diminish the power of the cloth to combine with the yellow

Prussiate green.—Prussian blue is employed as a basis in the same manner, only not being capable of resisting chemical agents so well as indigo blue, it demands more care. The greens with Prussian blue bases are more lively than those made with indigo, but are not so fast. Sulphate of indigo is even less stable than Prussian blue. It is, however, cheap and easy of application, and gives rich colours. The greens made with chromate of lead are for the most part confined to cotton goods, and are not in much demand.

ORANGE COLOURS.

For cotton the chief orange-dye is the chromate of lead compound already described. For other materials the orange colours employed

are nearly always composed of some of the red and yellow dyes mentioned in the preceding pages, such, for instance, as cochineal and fustic, which are applied in one bath, the same mordant serving for both.

Arnotto orange.—A warm solution of arnotto in weak alkalies is used without mordant to impart to silk an agreeable orange shade. Its colour is generally considered too yellow, but may be made redder by treatment with weak acids, or by previously giving the silk a light red foundation.

Picric acid orange.—Another orange on silk can be dyed by superimposing on a light pink a yellow obtained from picric acid.

Nitric acid orange.—Silk can also be permanently stained of a yellowish orange by means of moderately strong nitric acid, which must, however, be applied with great care, since a more than momentary contact would be very injurious to the strength of the fibre. This method of dyeing silk was formerly much used for handkerchiefs; by protecting certain parts from the acid with melted wax or similar resists, white designs were produced upon an orange ground.

PURPLE COLOURS.

The purple colours may be held to include all shades produced by an admixture of red and blue, such for example as lilac, violet, mauve, &c., and are of immense variety.

Aniline purples.—Since their discovery aniline colours have been almost exclusively employed for dyeing silk and wool purple, yielding as they do shades which for lustre and purity surpass any obtainable from the older colouring matters, and possessing also a fair amount of stability. An aqueous solution of the dye without mordant is all that is required, and the goods when dyed need very little subsequent treatment. The aniline purples, violets, and mauves do not dye upon cotton without previous mordanting, and even then are so loose and unstable that they are only fitted for use where great fixity is not demanded, as for linings of clothing, &c. The most general mordant for the aniline purple colours on cotton consists of a tannate of tin obtained by first steeping the cotton in a solution of tannic acid, or in decoction of gall-nuts, sumach, or myrobalans, all of which contain tannic acid; after a The hours' contact a considerable quantity of tannic acid has become firmly attached to the cotton, and the goods, being now treated successively with stannate of soda and dilute sulphuric acid or in other ways, acquire a certain proportion of oxide of tin, and are prepared to receive the colours.

Madder purple.—But the purple colour *par excellence* upon cotton is obtained from madder or alizarin, the mordant being oxide of iron or a sub-salt of iron deposited on the fibre by treatment with the commercial pyrolignite of iron, commonly called iron liquor. This purple is remarkable for great permanency. It is very largely used in combination with black and white in the best kind of printed calicoes.

Archil purple.—Archil and cudbear are sources of purple colours on wool and silk. The shades produced are rich and beautiful; they are not, however, very permanent, and have been nearly superseded by the aniline colours. Of the few instances that can be cited of stuffs dyed purple by the direct union of red and blue colouring matters, the violet or purple woollen cloth used for ecclesiastical purposes is an example. The indigo colour is first fixed and cleansed, and then the cloth is dyed with cochineal and tin mordants in the way already described for dyeing scarlet. The purple thus obtained is a fast colour, but is very costly, and on that account is not much worked.

The common shades of purple, violet, lilac, &c., upon wool are obtained from logwood with a mordant of alum and tartar; the red woods are sometimes employed in conjunction with logwood for these colours, which are "topped" with archil to give them more brilliancy.

The extensive range of colours, comprising all the shades of brown, bronze, chocolate, nut, wood, drab, and grey, which may be considered as compounded of the three elementary colours, some one of the three predominating, can only be briefly treated of in this article. Most of them are actually produced by the use of dye-stuffs yielding the three simple colours; but there are colouring matters like catechu, which themselves yield brown colours, and others, such as logwood, which may be held to contain two or more of the simple colours, the blue predominating. A few illustrations will show how these triply compounded colours are produced by the dyer.

BROWN COLOURS.

Bronze brown on wool.—The wool is mordanted with alum and tartar in the usual way, and is then dyed in a mixture of fustic and madder or other equivalent red and yellow dye-stuffs; for fast colours a blue part can be communicated to it by the indigo vat. For a lower class of colours no indigo is used, but instead, a mixture of yellow wood (fustic or quercitron) with madder for the red, and logwood for the blue part; or again, the sulphate of indigo may be employed for the blue.

Tan brown.—According to Mr Jarmain, the wool is mordanted by boiling it for an hour with one per cent. of its weight of bichromate of potash; it is then washed, and transferred to the dyeing vessel, with the following percentages of its weight of materials:—madder, 3·2; fustic, 4·8; camwood, 2; barwood, 1·75; sumach, 2·1; with these materials it is boiled for two hours.

Dark drab.—From the same authority we take the following as the weights required to dye 100 lb wool, previously mordanted with 1 lb of bichromate of potash:—camwood, 6½ lb; sumach, 2 lb; madder, 2½ lb; fustic, 4 lb; logwood, 2½ lb; boil for one hour and a half, and afterwards, to darken the colour, pass into water containing 1 lb of sulphate of iron.

BLACK COLOURS.

Black, from a dyer's point of view, is compounded of the three simple colours, red, yellow, and blue, in a state of concentration; but in reality the blue predominates in all good black colours, and gives them their density and at the same time their lustre. What is called a dead black, crape black, or jet black, is the nearest approach to a neutral black, but even this would be brownish if the blue did not predominate. It is often extremely difficult to obtain a black dye to suit a particular market. Of ten pieces appearing equally black to the uninitiated, an expert would, perhaps, pronounce one to be sooty, another purple, another red, another brown, another green, and so on.

We should have to go back some years in the history of dyeing, to find a time when black was actually dyed with the three elementary colours. In some processes blue from indigo was first applied, and then, upon an alum mordant, red and yellow from madder and weld respectively; such a colour was unexceptionable for stability, but its great cost caused it to be disused.

At the present day, logwood is the chief dye-stuff for blacks upon wool or cotton, and gall-nuts and other astringents for silks. Aniline black, on account of obstacles to its application, cannot be said to have yet established itself in dyeing proper, though it is much and highly valued in calico printing.

Black dye upon silk.—Silk easily takes a black by treatment first with decoction of gall-nuts, and subsequently with a salt of iron. For blue blacks the silk is usually first dyed with Prussian blue, and then with gall-nut black. Extract of chestnut-wood with an iron mordant gives a good black. In modern black silk dyeing, materials are heaped upon the fibre which are not necessary to its colour, but which increase its weight in an extraordinary manner, so as not only to compensate for the loss of 25 per cent. of natural gum in the silk, but even, in some cases, to double or treble the original weight. The silk is, of course, much injured by the accumulation of foreign matters upon it, the fibre becoming harsh and brittle, and soon showing the effects of wear. The chief substances used for weighting are lead salts, catechu, iron, and galls, with soap or fatty matter, to soften in some degree the harshness these occasion.

Black upon wool.—Upon woollen cloth of fine quality, the black is dyed upon a basis of indigo blue, and, from the use of woad for this colour, such blacks are in England called "woaded blacks." The first process, therefore, in producing the best black is to dye the wool in the indigo vat of a tolerably deep shade of blue, and afterwards boil it in a mixture of logwood and sumach, treating it with sulphate of iron; the latter process being two or three times repeated, a very perfect and durable black is obtained, provided the indigo basis is sufficiently deep, and only a minimum quantity of logwood has been employed, say about one-fourth the weight of the sumach.

Common black.—Common blacks upon wool have no indigo in their composition, but are dyed chiefly with logwood and iron salts; the wool and logwood are heated together for some time, and then sulphate of iron is added to the dye-bath. In other blacks of somewhat better quality, the woollen is boiled for some time with solution of iron, copper, and aluminium salts, together with tartar, and when the mordanting oxides have been fixed, the colour is dyed up in logwood. The bichromate of potash mordant can also be used for the black dye, and the cloth can be "bottomed" with camwood or barwood; it is then dyed up with logwood, to which fustic or sumach may be added.

Black upon cotton.—Almost the only ordinary black in cotton dyeing is obtained from logwood with iron mordant; sumach is sometimes used, and very rarely the black is dyed upon an indigo blue basis by means of sumach or galls and iron. As before stated, aniline black has not yet been practically applied in dyeing cotton. A common method is to first heat the goods for some hours with decoction of sumach, wash mordant in sulphate of iron, and then dye in logwood; another method consists in fixing an iron basis upon the cotton by the method given above (page 573), and dyeing in logwood, along with a portion of sumach or fustic, according to the shade required.

Velvet dyeing.—The most important branch of black dyeing upon cotton goods, is that employed for cotton velvets and velveteens, in which it is desired to produce a rich lustrous effect; the process is long, tedious, and uncertain, consisting of successive