

The *succinates* are normal ( $R'_2C_4H_4O_4$ ) and acid ( $R'HC_4H_4O_4$ ), a double succinate of potassium and hydrogen ( $KHC_4H_4O_4, H_2C_4H_4O_4, H_2O$ ), analogous to the superacid oxalate, salt of sorrel, also exists.

Soluble succinates give a bulky brown precipitate with neutral ferric chloride, only less voluminous than ferric benzoate; a white precipitate with acetate of lead, soluble in excess of either reagent; with nitrate of silver, a white precipitate after a time; with chloride of barium, no precipitate at first, but a white one of succinate of barium on the addition of ammonia and alcohol. Succinates are distinguished from benzoates by the last-named reaction, and by not yielding a precipitate on the addition of acids (*vide* p. 336).

**SULPHOCYANIC ACID ( $HCyS$ ) AND OTHER SULPHOCYANATES.**—Boil together sulphur and solution of cyanide of potassium; solution of sulphocyanate of potassium ( $KCyS$ ) is formed. Warm the liquid, add hydrochloric acid till it faintly reddens litmus-paper, and filter; any sulphide of potassium is thus decomposed, and the solutions may then be used for the following reactions.

*Tests.*—Filter, and to a small portion of the solution add a ferric salt ( $Fe_2Cl_6$ ); a deep blood-red solution of ferric sulphocyanate is formed. To a portion of the red liquid add a little hydrochloric acid; the color is not discharged (meconate of iron, a salt of similar tint, is decomposed by hydrochloric acid). In the acid liquid place a fragment or two of zinc; sulphuretted hydrogen is evolved, and the red color disappears. To another portion of the ferric sulphocyanate add solution of corrosive sublimate; the color is at once discharged. (Ferric meconate is unaffected by corrosive sublimate.) The ferric is the best test of the presence of a sulphocyanate; indirectly, it is a good test of the presence of hydrocyanic acid or cyanogen. Solutions of pure ferrous salts are not colored by the solution of sulphocyanate. Red ferric acetate is decomposed by ebullition.

Neither the ferric acetate nor the meconate yields its color to ether; but on shaking ferric sulphocyanate solutions with ether the latter takes up the salt and becomes of a purple color.

To solution of a sulphocyanate add solution of mercuric nitrate; mercuric sulphocyanate is precipitated as a white powder.

*Pharaoh's Serpents.*—Mercuric sulphocyanate, thoroughly washed and made up into little cones, forms the toy called Pharaoh's Serpent. It readily burns when ignited, the chief product being a light solid matter (mellon,  $C_9N_{13}$ , and the melam,  $C_3H_6N_6$ ), which issues from the cone in a snake-like coil of extraordinary length. The other products are mercuric sulphide (of which part remains in

the snake and part is volatilized), nitrogen, sulphurous, and carbonic acid gases, and vapor of metallic mercury. (For details concerning the economical manufacture of sulphocyanates, see *Pharmaceutical Journal*, second series, vol. vii. p. 581 and p. 152.)

The sulphocyanic radical ( $CyS$ ) is often termed sulphocyanogen ( $Sey$ ), and its compounds regarded as *sulphocyanides*. Saliva contains sulphocyanates.

**TANNIC ACID, OR TANNIN** (*Acidum Tannicum*, U. S. P.,  $C_{14}H_{10}O_9$ , chiefly).—This is a common astringent constituent of plants, but is contained in largest quantity in galls (excrecences on the oak formed by the puncture and deposited ova of an insect). English galls contain from 14 to 28 per cent. of tannic acid; Aleppo galls (*Galla*, U. S. P.) from 25 to 65 per cent. It is present also in the White Oak (*Quercus Alba*, U. S. P.).

*Process.*—"Expose powdered galls (about an ounce is sufficient for the purpose of study) to a damp atmosphere for two or three days, and afterward add sufficient ether to form a soft paste. Let this stand in a well-closed vessel for twenty-four hours; then, having quickly enveloped it in a linen cloth, submit it to strong pressure so as to separate the liquid portion, which contains the bulk of the tannin in solution. Reduce the pressed cake to powder, mix it with sufficient ether, to which one-sixteenth of its bulk of water has been added, to form again a soft paste, and press this as before. Mix the expressed liquids, and expose the mixture to spontaneous evaporation until, by the aid subsequently of a little heat, it has acquired the consistence of a soft extract; then place it on earthen plates or dishes and dry it in a hot-air chamber at a temperature not exceeding  $212^{\circ}$ ."

The resulting tannic acid occurs in pale yellow vesicular masses or thin glistening scales, with a strongly astringent taste and an acid reaction, readily soluble in water and rectified spirit, very sparingly soluble in pure ether, though soluble in the ethereal fluid used in the foregoing process—a fluid which is really a mixture of true ether, water, and alcohol (both the latter contained in the common "ether"), and a little added water also.

*Medicinal Uses.*—Tannic acid is very soluble in water, and in this form is usually administered in medicine.

*Tests.*—To an aqueous solution of tannic acid add aqueous solution of gelatine; a yellowish-white flocculent compound of the two substances is precipitated. This is a good test of the presence of tannic acid.

*Tanning.*—The above reaction also serves to explain the chemical principle involved in *tanning*—the operation of converting skin into



leather. In that process the skin is soaked in infusion of oak-bark (*Quercus cortex*), the tannic acid of which, uniting with the gelatinous tissues of the skin, yields a compound very well represented by the above precipitate. The outer bark of the oak contains little or no tannic acid, and is commonly shaved off from the pieces of bark which are large enough to handle; useless coloring-matter is thus also rejected. Other infusions and extracts besides that of oak-bark (chiefly catechu, sumach, and valonia) are largely used by tanners: if used alone these act too quickly, and give a harsh, hard, less-durable leather. The tannic acid of these preparations is probably slightly different from that of oak-bark.

To an aqueous solution of tannic acid add a neutral solution of a ferric salt; dark bluish-black tannate of iron is slowly precipitated. This is an excellent test for the presence of tannic acid in vegetable infusions. The precipitate is the basis of nearly all black *writing-inks*. Ferrous salts give at first only a slight reaction with tannic acid; but the liquid gradually darkens. Characters written with this liquid become quite black in a few hours, and are very permanent.

To an aqueous solution of tannic acid add solution of tartar-emetic; tannate of antimony is precipitated. This reaction and that with gelatin are useful in the quantitative estimation of the amount of tannic acid in various substances, the separation of the tannate of gelatin being much promoted by previously adding some heavy neutral powder, such as sulphate of barium, and well stirring while pouring in the gelatin solution.

*Tannic acid* as it occurs in oak-bark is said to be a glucoside, that is, like several other substances, yields glucose (grape-sugar) when boiled with dilute sulphuric or hydrochloric acid, the other product being gallic acid.

*Catechu*, *Gambier*, or *Terra Japonica*, an extract of the *Uncaria Gambier*; as well as the true *Catechu*, *Cutch*, or *Terra Japonica*, an extract from the *Acacia catechu* (*Catechu*, U. S. P.; *Catechu nigrum*; P. I.) and *A. Suma*; *East Indian Kino* (*Kino*, U. S. P.) from the *Pterocarpus marsupium*; also *Bengal* or *Butea Kino*, from the *Palas* or *Dhak* tree, *Butea frondosa* (*Butea gummi vel Kino Bengalensis*, P. I.); and some other vegetable products, contain a variety of tannic acid (*mimotannic acid*), which gives a greenish precipitate with neutral solutions of ferric salts. According to Paul and Kingzett, it yields, when decomposed, unfermentable sugar, and an acid different from ordinary gallic acid. *Catechu* and *Gambier* also contain *catechuic acid* or *catechin*,  $C_{15}H_{10}O_5$ , a body occurring in minute colorless acicular crystals, and, like *mimotannic acid*, affording a green precipitate with ferric salts.

*Bael fruit* (*Belæ Fructus*, B. P.), from the *Ægle Marmelos*, is said to owe its power as a remedy for dysentery and diarrhoea to a variety of tannic acid, but this is questionable. About 10 per cent.

of tannic acid is contained in the leaves of *Castanea vesca* (*Castanea*, U. S. P.), the tree yielding the common edible Spanish chestnuts. The rind of the fruit of the *pomegranate* (*Punica granatum*) (*Granati Cortex*, P. I.) contains tannic acid. The astringency of Pomegranate-root Bark (*Granatum*, U. S. P.) is due to a tannic acid (its anthelmintic properties probably to a resinoid matter, or possibly to what Tanret states to be a liquid alkaloid, *pellitierine*,  $C_{16}H_{30}N_2O_2$ ). A tannic acid also probably gives the astringency to Logwood (*Hæmatoxylon*, U. S. P.). Rhatany-root bark (*Krameria*, U. S. P.) contains about 20 per cent. of tannic acid, its active astringent principle; rhubarb-root, about 9 per cent. *Bearberry-leaves* (*Uva Ursi*, U. S. P.) owe most of their therapeutic power to about 35 per cent. of tannic acid. (The cause of their influence on the kidneys is not yet traced.) They also contain *arbutin*, a crystalline glucoside. *Larch-bark* (*Laricis Cortex*, B. P.), the inner bark of *Pinus larix* or *Larix europæa*, contains, according to Stenhouse, a considerable amount of a tannic acid giving olive-green precipitates with salts of iron, and *larixin* and *larixinic acid* ( $C_{10}H_{10}O_5$ ), a somewhat bitter substance. *Areca nuts* or *Betel nuts* (*Areca*, B. P.), from the *Areca Palm* (*Areca catechu*), besides the alkaloid *arekane* (Bombelon), contain a very active alkaloid, *arecoline*,  $C_8H_{13}NO_2$  (Jahns), said to be the vermifugal principle, and, according to Flückiger and Hanbury, about 15 per cent. of "tannic matter." The extract of the fruit of *Gab*, or *Diospyros embryopteris* (*Diospyri Fructus*, P. I.), is a powerful astringent containing tannic acid. The rhizome (*Geranium*, U. S. P.) of *Geranium maculatum*, Spotted Cranesbill or Arum-root, contains both tannic and gallic acids. *Sumac* or *Shumac*, or *Sumach*, the leaves and stalks of various species of *Rhus*, chiefly *Rhus coriaria*, contains ordinary tannic acid and gallic acid. The fruit of sumach (*Rhus glabra*, U. S. P.) contains tannic and much malic acid. The bark of *Prinos verticillatus*, the *Black Alder* or *Winterberry* (*Prinos*, U. S. P.), contains tannin and a bitter principle. The principal constituent of the bark of the root of *Rubus villosus*, or *high blackberry*, and of *R. canadensis* and *R. trivialis* (*Rubus*, U. S. P.), is tannic acid.

*Gallic Acid* ( $H_3C_7H_3O_5 \cdot H_2O$ ) (*Acidum Gallicum*, U. S. P.) occurs in small quantity in oak-galls and other vegetable substances, but is always prepared from tannic acid. Powdered galls are moistened with water and set aside in a warm place for five or six weeks, or until a little treated with water and filtered yields a solution which is only slightly precipitated with solution of isinglass, occasionally being remoistened; fermentation occurs, and impure gallic acid is formed. The product is treated with about three times its weight of water, boiled to dissolve the gallic acid, filtered, the solution set aside to cool, deposited gallic acid collected, drained, pressed between folds of paper to remove all mother-liquor, and, if necessary, purified by recrystallization from water, or by solution in hot water with animal charcoal, which absorbs coloring-matter.



On filtering and cooling, most of the acid separates in the form of fawn-colored, slender acicular crystals. Gallic acid is soluble in 118 times its weight of cold or 3 of boiling water, freely in spirit, sparingly in ether, also in glycerin.

The nature of the action by which gallic acid is thus produced is probably similar to that of the action of dilute acids on tannic acid. During the process oxygen is absorbed and carbonic acid gas evolved, the sugar being thus broken up or perhaps prevented from being formed.

*Test.*—To an aqueous solution of gallic acid add a neutral solution of ferric salt; a bluish-black precipitate of gallate of iron falls, similar in appearance to tannate of iron. Ferrous salts are also blackened by gallic acid. To more of the solution add an aqueous solution of gelatin; no precipitate occurs. By the latter test gallic acid is distinguished from tannic acid.

*Pyrogallol Acid or Pyrogallol* ( $C_6H_6O_3$ ).—This substance sublimes in light feathery crystals when gallic acid is heated. Or it may be formed by heating gallic acid with 3 or 4 times its weight of glycerin to  $190^\circ$  or  $200^\circ$  C. for a short time until carbonic acid gas ceases to be evolved. Longer heating at a lower temperature is not equally effective, and below  $100^\circ$  C. probably no pyrogallol is produced (Thorpe). To an aqueous solution add a neutral solution of a ferric salt, a red color is produced. To another portion add a ferrous salt; a deep-blue color results.

*Test for the Three Acids.*—To three separate small quantities of milk of lime in test-tubes add, respectively, tannic, gallic, and pyrogallol acids; the first slowly turns brown, the second more rapidly, while the pyrogallol mixture at once assumes a beautiful purplish-red color, changing to brown. These reactions are highly characteristic. They are accompanied by absorption of oxygen from the air.

*Use of Pyrogallol Acid in Gas-analysis.*—A mixture of pyrogallol acid and solution of potash absorbs oxygen with such rapidity and completeness that a strong solution of each, passed up successively by a pipette into a graduated tube containing air or other gas, forms an excellent means of estimating free oxygen. The value of this method may be roughly proved by pouring a small quantity of each solution into a phial, immediately and firmly closing its mouth with a cork, thoroughly shaking the mixture, and then removing the cork under water; the water rushes in and occupies about one-fifth of the previous volume of air, indicating that the atmosphere contains one-fifth of its bulk of oxygen. The small amount of carbonic acid gas present in the air is also absorbed by the alkaline liquid; in delicate experiments this should be removed by the alkali before the addition of pyrogallol acid.

*Toxicodendric Acid* is the volatile, excessively acid and poisonous principle of the Poison Oak or Poison Ivy, the fresh leaves of which are official (*Rhus toxicodendron*, U. S. P.), Maisch.

**URIC ACID** ( $H_2C_5H_2N_4O_3$ ) AND OTHER URATES.—Acidulate a few ounces of human urine with hydrochloric acid, and set aside for twenty-four hours; a few minute crystals of uric acid will be found adhering to the sides and bottom of the vessel and floating on the surface of the liquid.

*Microscopical Test.*—Remove some of the floating particles by a slip of glass, and examine by a powerful lens or microscope; the chief portion will be found to be in yellowish semi-transparent crystals, more or less square, two of the sides of which are even, and two very jagged; but other forms are common (see the lithographs in the section on Urinary Sediments.)

*Chemical Test.*—Collect more of the deposit, place in a watch-glass or small white evaporating-dish, remove adherent moisture by a piece of blotting- or filter-paper, add a drop or two of strong nitric acid, and evaporate to dryness; the residue will be red. When the dish is cold add a drop of solution of ammonia; a purplish-crimson color results. The color is deepened on the addition of a drop of solution of potash.

*Notes.*—Uric acid (or lithic acid) and urates (or lithates) of sodium, potassium, calcium, and ammonium are common constituents of animal excretions. Human urine contains about one part of urate (usually urate of sodium) in 1000. When more than this is present the urate is often deposited as a sediment in the excreted urine, either at once or after standing a short time. Uric acid or other urate is also occasionally deposited before leaving the bladder, and, slowly accumulating there, forms a common variety of urinary calculus.—Some urates are not definitely crystalline; but when treated with dilute nitric acid or a drop of solution of potash, and then a drop or two of acetic acid, jagged microscopic crystals of uric acid are usually formed.—All urates yield the crimson color when treated as above described. This color is due to a definite substance *murexid* ( $C_8H_8N_6O_6$ ) (from the *murex*, a shell-fish of similar tint); and the test is known as the *murexid test*. The formation of murexid is due to the action of ammonia on *alloxan* ( $C_4H_2N_2O_4 \cdot 4H_2O$ ) and other white crystalline products of the oxidation of uric acid by nitric acid. Murexid is a good dye; it may be prepared from *guano* (the excrement of sea-fowl), which contains a large quantity of urate of ammonium. The excrement of the serpent is almost pure ammonium urate.

Uric acid and the urates will be again alluded to in connection with the subject of morbid urine.

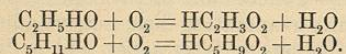
*Constitution of Uric Acid.*—The physiological and pathological importance of uric acid has obtained for it great attention from chemists, a knowledge of its composition being rightly regarded as amongst the most prominent of chemical desiderata. For an excellent résumé of what has been done in this direction up to 1884, students of or-



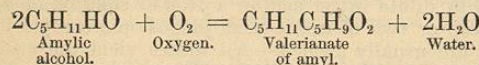
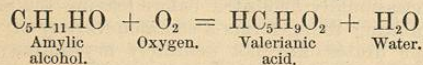
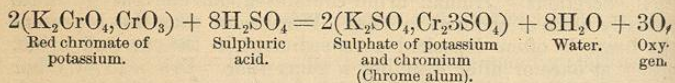
ganic chemistry may consult the *Pharmaceutical Journal* of Nov. 22, 1884.

**VALERIANIC ACID OR VALERIC ACID ( $\text{HC}_5\text{H}_9\text{O}_2$ ) AND OTHER VALERIANATES.**—In a test-tube place a few drops of amylic alcohol (fusel oil) with a little dilute sulphuric acid and a grain or two of red chromate of potassium, cork the tube, set aside for a few hours, and then heat the mixture; valerianic acid, of characteristic valerian-like odor, is evolved.

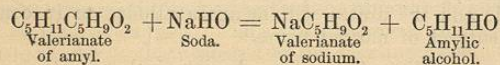
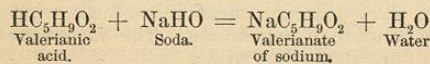
Valerianic acid occurs naturally in valerian-root in association with the essential oil from which it is derived (*vide* Index), but is usually prepared artificially, by the foregoing process, from amylic alcohol, to which it bears the same relation as acetic acid does to common alcohol:—



*Valerianate of Sodium* ( $\text{NaC}_5\text{H}_9\text{O}_2$ ) is prepared from the valerianic acid and valerianate of amyl obtained on distilling the mixture of amylic alcohol (4 fl. oz.), sulphuric acid ( $6\frac{1}{2}$  fl. oz. with 10 of water), and red chromate of potassium (9 oz. in 70 of water). The mixture should stand for several hours before heat is applied.



The distillate (70 or 80 oz.) is saturated with soda, which not only yields valerianate of sodium with the free valerianic acid, but decomposes the valerianate of amyl produced at the same time, more valerianate of sodium being formed and some amylic alcohol set free, according to the following equations:—



From the solution of valerianate of sodium (which should be made neutral to test-paper by careful addition of soda solution) the solid white salt is obtained by evaporation to dryness and cautious fusion of the residue. The mass obtained on cooling

should be broken up and kept in a well-closed bottle. It is entirely soluble in spirit.

*Other Valerianates*, as valerianate of zinc (*Zinci Valerianas*, U. S. P.) and ferric valerianate (*Ferri Valerianas*, U. S. P.;  $\text{Fe}_2\text{C}_5\text{H}_9\text{O}_2$ ), may be made by double decomposition of valerianate of sodium with the sulphate or other salt of the metal the valerianate of which is desired, the new valerianate either precipitating or crystallizing out. A hot solution of sulphate of zinc ( $5\frac{1}{4}$  parts) and valerianate of sodium (5 parts) in water (40 parts) gives a crop of crystals of valerianate of zinc on cooling.

*Tests.*—Heated with diluted sulphuric acid, valerianates of the metals give valerianic acid, which has a highly characteristic smell. Valerianate of sodium thus treated, and the resulting oily acid liquid purified by agitation with sulphuric acid and distillation, furnishes valerianic acid. Dry ammonia gas passed into valerianic acid gives white lamellar crystals of valerianate of ammonium (*Ammonii Valerianas*, U. S. P.).

The amylic alcohol ( $\text{C}_5\text{H}_{11}\text{HO}$ ) from which valerianates are prepared may contain the next lower homologue, *butylic alcohol* ( $\text{C}_4\text{H}_9\text{HO}$ ). This, during oxidation, will be converted into *butyric acid* ( $\text{HC}_4\text{H}_7\text{O}_2$ ), the next lower homologue of valerianic acid ( $\text{HC}_5\text{H}_9\text{O}_2$ ), and hence the various valerianates be contaminated by some *butyrates*. These are detected by distillation with diluted sulphuric acid and addition of solution of acetate of copper to the distillate, which at once becomes turbid if butyric acid be present. In this reaction valerianic and butyric acids are produced by double decomposition of the valerianate and butyrate by the sulphuric acid, and distil over on the application of heat. On the addition of acetate of copper ( $\text{Cu}_2\text{C}_2\text{H}_3\text{O}_2$ ) butyrate of copper ( $\text{Cu}_2\text{C}_4\text{H}_7\text{O}_2, \text{H}_2\text{O}$ ) is formed, and, being almost insoluble in water, is at once precipitated, or remains suspended, giving a bluish-white opalescent liquid. Valerianate of copper ( $\text{Cu}_2\text{C}_5\text{H}_9\text{O}_2$ ) is also formed after some time, but is far more soluble than the butyrate, and only slowly collects in the form of greenish oily drops, which gradually pass into greenish-blue hydrous crystalline valerianate of copper (Larocque and Hurlalt).

**VANILLIC ACID** ( $\text{HC}_8\text{H}_7\text{O}_3$ ) or **VANILLIN** ( $\text{C}_8\text{H}_8\text{O}_3$ ) or **METHYLPROTOCATECHUIC ALDEHYDE** ( $\text{C}_7\text{H}_5\text{CH}_3\text{O}_3$ ), the body to which is due the odor and flavor of Vanilla.—The white crystals commonly found on vanilla—the prepared unripe pods of *Vanilla planifolia*—previously termed *vanillin*, were found by Carles to be a weak acid. It occurs in vanilla to the extent of from  $1\frac{1}{2}$  to 3 per cent. Vanillin has recently been prepared artificially by Tiemann and Haarmann from coniferin, a glucoside existing in the sapwood of pines. The body remaining after the removal of glucose from coniferin or, indeed, coniferin itself, by action of a mixture of red chromate of potas-



sium and sulphuric acid, yields the vanillin. It also may be obtained by a series of reactions starting from that of carbonic acid on carbolate of potassium; also from the eugenol of oil of cloves. By action of hydrochloric acid, vanillin yields chloride of methyl and protocatechuic aldehyd. Such reactions will be better understood when the pupil has studied succeeding sections on what is commonly termed *Organic Chemistry*. Artificial vanillin is less stable than natural vanillin, perhaps because with the latter is associated a preservative resin.

#### QUESTIONS AND EXERCISES.

619. What is the constitution of nitrites?
620. Mention a test for nitrites in potable waters.
621. Which nitrite is official?
622. Give the names of some natural and artificial silicates.
623. What is "soluble glass"?
624. Distinguish between silica and silicic acid.
625. How are silicates detected?
626. What is the quantivalence of silicon?
627. Mention the sources, formulæ, and analytical reactions of succinates.
628. State the mode of manufacture and tests of sulphocyanates.
629. What proportion of tannic acid is contained in galls?
630. Describe a process for the preparation of Tannic Acid?
631. Explain the chemistry of "tanning."
632. Enumerate the tests of tannic acid.
633. What is the assumed constitution of tannic acid?
634. Mention official substances other than galls whose astringency is due to tannic acid.
635. How is gallic acid prepared?
636. By what reaction is gallic distinguished from tannic acid?
637. Mention the characteristic properties of pyrogallie acid.
638. Explain the murexid test for uric acid.
639. Describe the artificial preparation of valerianic acid and other valerianates, giving diagrams or equations.
640. What is the formula of valerianic acid?
641. How are butyrates detected in presence of valerianates?

#### DETECTION OF THE ACIDULOUS RADICALS OF SALTS SOLUBLE IN WATER.

Analytical operations may now be resumed, the detection of acidulous radicals being practised for two or three days, and then full analyses made, both for basylous and acidulous radicals. To this end a few compounds of stated metals (potassium, sodium, or ammonium) should be placed in the hands of the practical student for

examination according to the following paragraphs and Tables. Mixtures in which both basylous and acidulous radicals may be sought should then be analyzed.

In examining salts soluble in water, and concerning which no general information is obtainable, search must first be made for any basylous radicals by the appropriate methods (*vide* page 220 or 256). Certain metals having been thus detected, a little reflection on the character of their salts will at once indicate what acidulous radicals may be, and what cannot be, present. Thus, for instance, if the substance under examination is freely soluble in water, and lead is found, only the nitric and acetic radicals need be sought, none other of the lead salts than nitrate or acetate being freely soluble in water. Moreover, the salt is more likely to be acetate than nitrate of lead, for two reasons: the former is more soluble than the latter, and is by far the commoner salt of the two. Medical and pharmaceutical students have probably, in dispensing, already learned much concerning the solubility of salts, and whether a salt is rarely employed or in common use. And although but little dependence can be placed on the chances of a salt being present or absent according to its rarity, still the point may have its proper weight. If, in a mixture of salts, ammonium, potassium, and magnesium have been found associated with the sulphuric, nitric, and hydrochloric radicals, and we are asked how we suppose these bodies may exist in the mixture, it is far more in accordance with common sense to suggest that sal-ammoniac, nitre, and Epsom salt were originally mixed together than to suppose any other possible combination. Such appeals to experience regarding the solubility or rarity of salts cannot be made by any one not previously acquainted, or insufficiently acquainted, with the characters of salts: in such cases the relation of a salt to water and acids can be ascertained by referring to the following Table (p. 367) of the solubility or insolubility of about five hundred of the common or rarer salts met with in chemical operations.

The opposite course to the above (namely, to ascertain what acidulous radicals are present in a mixture, and then to appeal to experience to tell what basylous radicals may be and what cannot be present) is impracticable; for acidulous radicals cannot be separated out, one after the other, from one and the same quantity of substance by a similar treatment to that already given for basylous radicals. Indeed, such a sifting of acidulous radicals could scarcely be accomplished at all, or only by a vast deal of labor. The basylous radicals must, therefore, be first detected.

Even when the basylous radicals have been found, the acidulous radicals which may be present must be sought for singly, the only additional aid which can be brought in being the action of sulphuric acid, a barium salt, a calcium salt, nitrate of silver, and ferric chloride on *separate* small portions of the solution under examination, as detailed in the second of the following Tables.

#### Practical Analysis.

Commence the analysis of an aqueous solution of a salt or