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Black-and-White Photographic Chemistry

A Reference

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NASA

PREFACE

When I started to compile this information in the early 1950's, it was for my personal use. It was common practice at the time for photographers to use a variety of chemicals in their daily work. Every time I found a useful bit of information I added it to my collection. This volume is the result. It is intended not as a complete work (that would involve several volumes) but merely as a collection of the hard-to-find information for which I have always searched.

Caution should be exercised in handling and disposing of the selected chemicals listed herein. Some have been ruled hazardous to health or to the environment.

The meat of the collection, presented in the section "General Chemicals and Raw Materials," was gleaned from numerous sources. The remainder of the text, except for the international atomic weights, is reproduced with minor editoral revision from two Air Force Manuals, "Basic Photographs" (95-1, 1953) and "Principles and Practices for Precision Photographic Processing" (95-13, 1966).

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BLACK-AND-WHITE PHOTOGRAPHIC CHEMISTRY - A REFERENCE

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PRINCIPLES OF PHOTOGRAPHIC CHEMISTRY

Daguerre, with his discovery in 1839 of the latent image that could be developed, became the father of photographic chemistry. Fox-Talbot is credited with the first fixing process. He used sodium chloride (salt) as the fixing agent. Upon the suggestion of Sir John Herschell, the change was made from salt to sodium thiosulfate (hypo), our present-day fixing agent. Because of the great number of advances made in the field of photographic chemistry, it is not practical to describe them fully. But since the greater portion of the photographer's work consists of processing sensitized emulsions, it is advisable that he or she understand the basic principles of photographic chemistry.

CHEMISTRY OF DEVELOPMENT

When a photographic emulsion is exposed to light by proper means, an invisible (latent) image is formed by the silver halides in the emulsion. There are many theories as to the exact nature of the change that takes place in this reaction. It is sufficient to know that light weakens the structure of the affected halides in such a manner as to permit their reduction to metallic silver. This reduction forms the visible image. It is accomplished with a chemical, known as a reducing agent, that combines with oxygen. Oxygen enables the agent to react with the exposed silver halides and separate or reduce the silver.

Although the reducing agent is the most important chemical in a developing solution, other ingredients are necessary to make the solution function properly. If used alone, most reducing agents have little or no effect on the silver halides because of their low rate of reduction. To speed up the oxidation of the reducing agent, an alkali or accelerator is generally added. This accelerator, besides energizing the reducer, also softens the gelatin of the emulsion and allows faster penetration of the solution. But a reducer and an accelerator in solution oxidize, causing too rapid action. This reduces not only the exposed but also the unexposed silver halides, leaving a veil of silver deposited throughout the emulsion. The veil is called chemical fog. Excessive oxidation also causes stains in the emulsion and rapid deterioration of the solution. To prevent the reduction of unexposed silver halides, a restrainer is added, thus making the solution selective. To minimize the formation of stains and extend the life of the developing solution, a preservative, which has an affinity for oxygen, is added.

Reducing Agents

Although many chemicals are capable of reducing silver halides to metallic silver, relatively few of them can be used. Many tend to reduce the unexposed as well as the exposed silver halides; that is, they are not selective in their action. The few used vary greatly in their properties.

One of the properties of a reducing agent is its reducing potential. This refers to its relative ability to develop or reduce the silver halides. A reducing agent of high potential attacks silver halides vigorously; one of low potential is slower in its action. The characteristic activity of a reducing agent is another property to consider. Some agents are more active in the highlight areas and some in the shadow areas; still others have overall activity. The temperature of the solution affects the activity of some agents much more than others. The tone of the developed image is greatly affected by the type of reducing agent. Some agents produce blue-black (cold) tones, while others yield brownish (warm) tones. Metol hydroquinone, amidol, glycin, paraphenylene diamine, and pyro are some of the more widely known developing agents.

Hydroquinone is a developing agent of low potential. It requires little or no restrainer at normal temperature and becomes inert (inactive) at about 50 °F in normal solutions. Above 80 °F it tends to produce fog. Hydroquinone is capable of producing highlights of great density in a negative while retaining transparency in unexposed areas. This makes it an ideal developing agent for subjects requiring extreme contrast - copies of black-and-white line drawings. For subjects that require the correct rendering of halftones and shadows, hydroquinone is combined with another reducing agent such as Metol. Hydroquinone deteriorates slowly in air, has good keeping qualities in solution, and does not stain the gelatin.

Metol (Elon, Pictol, Rhodol, etc.) is a trade name for monomethyl paraminophenol sulfate. Metol alone, or in combination with hydroquinone, has been one of the most popular of all developers since its introduction in 1891. It builds image detail rapidly and is a soft-working, high-potential developing agent, affected comparatively little by changes in temperature or by the presence of large amounts of restrainer. Although Metol will reduce silver halides without an accelerator, it is generally used with carbonate. Sometimes borax and other alkalis are employed for special purposes. At times it is difficult to secure sufficient contrast with Metol alone; hence it is usually combined with hydroquinone. Other combinations are Metol glycin and Metol pyro. Metol is used in fine-grain negative developers, in general-purpose developers (with hydroquinone) for prints and negatives, and in pyro developers for negatives. Metol solutions have good keeping qualities.

Metol hydroquinone, abbreviated to M-Q, is the most versatile and popular of all developers. The soft-working, detail-producing Metol and the high-contrast hydroquinone make a combination superior in many ways to either agent when used alone. M-Q developer keeps well in solution, does not stain, and is faster working than either Metol or hydroquinone used separately.

Amidol (diaminophenol) has the highest developing potential. It is one of the few reducing agents that can be used without an accelerator or restrainer. A solution of amidol and a preservative gives satisfactory results. Its main disadvantage is that it oxidizes and deteriorates very rapidly.

Glycin is a low-potential developing agent that works satisfactorily on the lesser exposed, as well as the more exposed, areas. It is nonstaining, produces fine grain, and does not readily oxidize in either air or alkali solutions, even when greatly diluted. This makes it very useful for machine development of motion picture film. It is often used in combination with other developers.

Pyro (pyrogallol) has been in use longer than any other organic developing agent, but it has some disadvantages that limit its use. It deteriorates rapidly when in a working solution and is highly staining, making it suitable only for negative materials. However, the stain produces another image, in addition to the regular silver image, and this adds to the printing quality of a thin negative.

Diamine (paraphenylene diamine) has a low reduction potential. It produces negatives of good tonal range, fine grain, and warm tones. Slight increases in temperature have little effect on its activity. It is somewhat toxic and, like Metol, may cause skin irritations.

Accelerators

All developing agents are either neutral or slightly acid and, as such, usually have little reducing ability. To function as reducers, these agents must be made alkaline by adding an accelerator. The accelerator energizes the reducing agent and softens the emulsion, permitting more rapid penetration of the developing solution. A deficiency of alkali retards development; an excess results in an increase in activity and contrast, eventual chemical fog, and an overswelling of the gelatin that may cause frilling and blisters.

Accelerators are divided into three general types: mild, moderate, and strong. Borax, a mild alkali, is used with low-contrast developers for fine grain. It is sometimes called a "buffer" alkali because in solution it slowly and constantly forms or releases its alkali, keeping the alkalinity of the solution constant. Borax is the mildest alkali in common use for the development of negatives only. Sodium metaborate, although slightly stronger, is similar in its action to borax.

Sodium carbonate (Na_2CO_3), a moderate alkali, is the accelerator most commonly used in developing solutions. It is used in many Metol-hydroquinone and pyro solutions. Potassium carbonate (K_2CO_3) can be substituted in formulas calling for sodium carbonate. It is more soluble in water but more expensive and less stable than sodium carbonate.

Sodium hydroxide (NaOH) and potassium hydroxide (KOH) are caustic alkalis used with certain developers to produce high contrast. Caustic alkalis are avoided for fine-grain developers because they soften and swell the gelatin excessively, permitting the silver grains to clump together.

Other alkalis that are in more or less common use are ammonium carbonate, ammonia, acetone, sodium metaborate, and paraformaldehyde. A strong alkali does not give the same results as a weak one even though allowance is made for the difference in strength. Therefore substitution should not be attempted.

Because the accelerator is a determining factor in the activity of a developing solution, it markedly influences the degree of graininess produced in the negative. Graininess depends on the clumping action of the silver grains during the development process. The more active the developer, the greater the clumping action; therefore the milder or less alkaline developing solutions yield finer grain.

Preservatives

All organic developing agents in an alkaline state have a strong affinity for oxygen. Therefore a preservative must be added to developing solutions to prevent excessive oxidation. The preservative prolongs the usefulness of the developing solution and prevents the formation of colored oxidation products, which cause stains. Sodium sulfite (Na_2SO_3) is the preservative most commonly used. Sodium sulfite dissolves silver bromide to some extent and therefore is useful for reducing grain size in fine-grain developers. Sodium bisulfite (Na_2HSO_3) is also used. This is an acidified sulfite that in an alkaline developer is converted to sodium sulfite and sodium bicarbonate. Developers containing sodium bisulfite give slightly less base fog than those containing sodium sulfite. The quantity of preservative required varies greatly, according to the following factors:

(1) The tendency of the developing agent or agents to oxidize

(2) The concentration of the developer. A dilute developer requires more preservative than a more concentrated solution.

(3) The temperature at which the developer is kept or used. The rate of oxidation increases as the temperature rises.

(4) The keeping properties required and the way in which the solution is used. A solution that is to be used once and then discarded requires only a small amount of preservative. The amount of oxidation is greater when a developing solution is used in a tray than when it is used in a tank.

(5) The alkalinity of the solution. The more strongly alkaline the developer, the more rapid is the rate of oxidation.

Restrainers

Without a restrainer most developers act too rapidly and reduce unexposed halides near the surface of the emulsion, causing chemical fog, developing streaks, and producing an image lacking in contrast. When a restrainer is added, development time is prolonged and fog is minimized. Excessive amounts of restrainer greatly retarded development and under some conditions cause greenish tones in prints. Potassium bromide (KBr) is the chemical most commonly used as a restrainer. All negative and some paper emulsions are basically composed of silver bromide. In development the bromide is released from the silver. Although this bromide acts as a restrainer, it is usually insufficient to prevent fog. Sodium bromide or sodium chloride is sometimes substituted for potassium bromide. Another chemical, potassium iodide, is sometimes used. It gives more restraining action and tends to produce blue-black tone, but its longer fixation time limits its use.

Many factors affect the processing of an emulsion - the type of developing solution, the time, the temperature, the amount of dilution, the kind and rate of agitation during processing, the type of emulsion, and the exposure. Other factors remaining constant, a rise in temperature speeds up development. This, in turn, increases contrast, fogging tendencies, and graininess. Diluting the developing solution slows development and decreases the contrast and fogging tendency, but it usually requires longer development time. Agitation also greatly influences the rate of development.

All these factors must be properly balanced for satisfactory results. Included in every film container is a data sheet with information on exposure and processing. This data sheet gives the recommended developer, the dilution, the time and temperature, and the method of agitation. A temperature of 68 °F should be maintained during the entire developing period. If the room temperature cannot be controlled, the solution temperature can usually be maintained constant by using a relatively large volume of solution or a water jacket.

Agitation can be one of three types:

(1) Constant - which means the film is constantly being moved, as in tray development or mechanical tank agitation

(2) Intermittent - meaning that the film is agitated several times a minute, as in the usual tank development

(3) Stagnant - no agitation, usually not recommended except in special cases

A different development time is listed for each type of agitation.

CHEMISTRY OF FIXATION

Rinsing

When a negative or print is removed from the developing solution, its emulsion is soft and swollen. There remains both in the emulsion and on its surface a small amount of developer that, if not removed, will continue its reaction and cause staining. To remove surplus developer, place the negative or print in a rinse bath. Rinse baths are of three general types: water, acid, and hardening. Each has its specific purpose and should be used accordingly.

A water rinse bath helps to retard development and removes excess developer from the emulsion, thus preventing contamination of the fixing bath. It is suitable for both negatives and prints and sometimes precedes the acid rinse in print processing.

An acid rinse bath stops all development by neutralizing the action of the developer, thus prolonging the life of the fixing bath. The rinse bath recommended is usually a weak solution of acetic acid. If an acid bath in not available, emulsions should be rinsed thoroughly in water.

A hardening rinse bath (chromium alum) is used to harden the emulsion in high-temperature and tropical processing. In ordinary processing the hardening agent in the fixing bath is sufficient, thus permitting the use of water or acid for a rinse.

Fixing

When a negative is removed from the rinse bath, there remains in the emulsion a considerable amount of silver halide that has not been affected by the developing solution. These undeveloped silver halides are sensitive to

light and, if allowed to remain in the emulsion, eventually darken, making the negative unusable. These halides are removed by changing them to a soluble state in a fixing bath. This bath usually contains more than one chemical agent. The chemical agents most commonly used are a silver halide solvent, an acid or neutralizer, a preservative, and a hardener.

Silver halide solvent. - All fixing baths must contain a chemical that is a silver halide solvent, also known as a fixer or fixing agent. The chemical most commonly used for this purpose is sodium thiosulfate, known as hypo. The sodium thiosulfate changes the silver halides to a compound that is soluble in water. Another chemical sometimes used as a fixing agent is ammonium chloride. To remove the unused silver halides, a fixing bath composed of sodium thiosulfate and water may be used. However, other factors to be taken into consideration require the addition of other agents.

Acid or neutralizer. - After development the pores of the thickened emulsion retain a considerable amount of the developer. If allowed to remain, it will continue its developing activity. Even though an emulsion is thoroughly rinsed in a nonacid rinse before it is placed in the fixing bath, a sufficient amount of the developer remains in the emulsion to continue this activity, causing the emulsion to become stained and unfit for use. To stop development and prevent staining, acetic acid is added to the fixing bath. This neutralizes the alkalinity of the developer.

Preservative. - When a sufficient quantity of acid is added to the fixing bath to neutralize the alkalinity of any remaining developer, the sodium thiosulfate is decomposed into free sulfur and sulfurous acid, making the bath unusable. To prevent the decomposition of the fixing bath, a preservative, sodium sulfite, is added. It combines with the sulfur and forms new sodium thiosulfate. Sodium sulfite not only prevents the acid from decomposing the sodium thiosulfate, but is also prevents discoloration of the solution and aids in eliminating stains.

Hardener. - It was previously stated that during development the gelatin softens and swells. If processing is continued without hardening the emulsion, frilling, scratching, or other undesirable effects may result. In the discussion on rinse baths, it was pointed out that the softened gelatin of the emulsion is sometimes hardened by treating it in a hardening solution before fixation. However, the most common practice is to include the hardening agent in the fixing bath. This allows the emulsion to be fixed and hardened at the same time. The most common hardening agent used in a fixing bath is potassium alum.

Types of Fixing Baths

Plain fixing bath. - The standard plain fixing bath is a 25 percent solution of hypo. It can be mixed by using 2 lb of hypo to each gallon of water. Plain fixing baths are seldom used for fixing solutions except for special purposes.

Acid fixing bath. - A satisfactory fixing bath may be made by adding sodium bisulfite (acidified sodium sulfite) to a hypo solution. The acid of the bisulfite stops development, and the sulfite preserves the solution and prevents its discoloration. Hypo combined with the proper proportions of

acetic acid and sodium sulfite also makes a suitable acid fixing bath. This type of bath is unsatisfactory for negatives because it has no hardening qualities. It is primarily intended for fixing prints.

Acid hardening-fixing bath. - An acid hardening-fixing bath contains a hardening agent, usually potassium alum, in addition to a silver halide solvent, a nuetralizing agent, and a preservative.

Boric acid hardening-fixing bath. - The hardening agent in an acid hardening-fixing bath causes the precipitation of aluminum sulfite when the acid becomes neutralized. Because of their much lower sludging tendencies and excellent hardening characteristics, fixing baths containing boric acid are recommended for films.

Chromium alum fixing bath. - This bath is especially suitable for hot-weather fixing because chromium alum hardens gelatin better than does potassium alum. It has one important disadvantage - its hardening properties rapidly deteriorate, so that the bath must be replaced frequently. It is recommended that chromium alum be used in a separate rinse bath, followed by a regular fixing bath. This results in a saving in chemicals.

Double fixing bath. - The use of two fixing baths is recommended especially for mass production of negatives or prints. Such a procedure results in a more uniform and thorough fixation, conserves chemicals, and speeds the production of a great number of prints. The method usually practiced for double fixing baths is to have two trays of equal amounts of the solution. The prints or negatives are fixed for half the time in the first tray and then moved to the second tray. Since the products of development are usually eliminated in the first bath, this bath deteriorates more rapidly than the second. When the first fixing bath shows signs of exhaustion, the second bath is moved into its place and a fresh bath is placed in the second position.

Exhausted fixing bath. - Some of the characteristics that signal exhaustion of the fixing bath are milky appearance, sulfurous odor, slippery feel, and bubbles that do not disappear. A fresh fixing bath will have the distinct pungent odor of acetic acid and will have a grippy feeling to the fingers. The large bubbles that form in an exhausted fixing bath during agitation do not disappear readily; those in a fresh bath do. The temperature and dilution of the fixing bath and the amount of agitation the print or negative receives during this process have a considerable effect on the rate of fixation and quality of the results obtained. All solutions in photographic processing should be mantained at approximately the correct working temperatures.

CHEMISTRY OF WASHING

Negatives and prints are washed to remove the chemical byproducts of the fixing bath. If these byproducts remain in the emulsion because of insufficient washing, they will in time cause it to change color, stain, or fade. The rate of washing depends largely on the diffusion of the hypo from the sensitized material. The rate of diffusion depends on the amount of fresh water coming into contact with the emulsion. The temperature of the water has little effect on the rate of washing as long as it is within 50 to 75 °F. Although

most salts diffuse more rapidly in warm water than in cold, when washing photographic material the warmer the water, the more the gelatin swells. Swelling retards the diffusion of the chemicals from the emulsion in about the same proportion as the rise in temperature accelerates it. Hardening the gelatin in the fixing bath does not influence the rate of washing unless the emulsion has been dried after fixing. If the emulsion has not been dried first, its shrinkage or contraction is negligible and has little or no effect on the rate of washing. If the gelatin has been dried, it will not swell as much when it is soaked again, and consequently the chemicals deeper in the emulsion will not be washed out as quickly. An idea of the actual rate of washing may be obtained if you realize that the hypo remaining in the sensitized material is continually halved in equal periods of time as the washing proceeds. An average negative, for instance, will give up approximately half of it hypo in 15 sec of direct contact with running water. After 30 sec one-fourth of the hypo remains, and so on, until eventually the amount of hypo remaining becomes negligible. The rate of washing then depends on the degree of agitation and the amount of fresh water with which the emulsion is brought into contact.

Washing in Trays

There are three methods of washing negatives and prints in trays. The simplest is to place the negatives or prints in a tray full of water and then change the water frequently. The second is to run a continuous stream of water into the tray for at least 20 min. The most efficient method uses a device attached to the edge of the tray that siphons the water from the bottom of the tray while fresh water is being run in at the top. In any method take care to separate the prints or negatives to ensure that sufficient fresh water reaches all areas.

Washing in Tanks

A very satisfactory method of developing negatives is the tank method. Metal or plastic frames hold the negatives and suspend them in the tank. Negatives developed in such a manner are washed in the same or a similar tank with fresh water flowing into it.

Mechanical Washers

Mechanical washers are convenient for washing large numbers of small and medium-size prints. These washers spray fresh water onto the prints while siphoning off the contaminated water from the bottom. This type of washer sometimes contains a large tray that is revolved either by the force of the water spray or by motor power. The rotation, together with the spray of water, constantly agitates the prints. In such washers the water is completely changed every few minutes.

Testing Solutions

It is possible to determine accurately whether prints and negatives have been sufficiently washed by using chemical tests. One method of testing is to remove several prints or negatives from the wash water and allow them to drain

into a violet, permanganate test solution. If the test solution becomes colorless, a large concentration of hypo is present; if it changes to an orange tone in about 30 sec, only a slight amount of hypo is indicated. In either case the prints should be returned to the wash water until further tests show no change in the color of the test solution. For preparation and use of hypo test solutions see appendix A.

CHEMISTRY OF REDUCTION AND INTENSIFICATION

Although a photographer strives to make perfect negatives, errors in exposure and development often occur. The resulting negatives may be dense or thin and flat, contrasty or fogged. Through special treatments, such as reduction or intensification, the negatives can be improved for easier printing. Such treatments, however, should be considered only as emergency measures, not as standard procedure. Observe the following general precautions before attempting either process:

(1) After fixation thoroughly wash the negative and make sure it is free from scum or stain.

(2) Because reduction or intensification excessively softens the emulsion, harden the film in a formalin hardening bath before treatment. (See appendix A.)

(3) Handle only one negative at a time to ensure best results.

(4) Following the treatment wash the negative thoroughly and swab it carefully before drying.

Reduction

The process by which a silver image is made less dense is called reduction. This should not be confused with chemical reduction (the developing of the latent image). There are three types of reducers - subtractive or cutting, superproportional, and proportional.

Subtractive, or cutting, reducers remove silver equally from all parts of the image. This decreases the overall density of the negative and appears to enhance contrast. This type of reducer is used to improve negatives that are dense due to overexposure and negatives that are slightly fogged. The most widely used subtractive reducer is a one-bath working solution known as Farmer's reducer. It is a mixture of potassium ferricyanide and hypo. The potassium ferricyanide oxidizes the silver and forms silver ferricyanide, which is dissolved by the hypo. (For formula and operating directions see appendix A.) Another type of subtractive reducer contains potassium permanganate, a very strong oxidizing agent. A solution of permanganate and sulfuric acid will oxidize the silver of the image to silver sulfate, which is soluble in water. If no acid is present, the permanganate acts only very weakly on the negative image and may be used to remove dichroic fog.

A superproportional reducer greatly reduces the dense areas of a negative without appreciably affecting the light or shadow areas. Therefore it is used

to lower excessive contrast. Only one such reducer is known - ammonium persulfate. This chemical, a powerful oxidizing agent, attacks the heavy silver deposit in the image and transforms it into silver sulfate, which dissolves in the solution. This reducer must be used in an acid solution and is somewhat uncertain in its action. Because reduction progresses with increasing rapidity, the negative must be closely watched and continually agitated during the process. This reducer should be mixed at least 24 hours before it is used. (See appendix A.)

Proportional reducers affect all parts of the negative in proportion to the density of the image and therefore decrease contrast as well as density. A negative that is dense and contrasty can be improved by treatment in this bath (appendix A). One type of proportional reducer is made by combining a subtractive and a superproportional reducer. For example, by combining potassium permanganate (subtractive) with ammonium persulfate (superproportional), a proportional reducer may be obtained. Farmer's reducer used as a two-bath formula will give almost the same results as a proportional reducer and will correct for overdevelopment. (See appendix A.)

Intensification

Intensification is the process by which the density and contrast of the silver image are enhanced. Before intensifying an image, comply with the precautions previously stated. There are three types of intensifiers in general use - mercury, chromium, and silver.

Mercury intensifiers are the most common because they are easier to use and less apt to cause damage to the emulsion. The negative is immersed in a solution, erroneously called a bleach, that deposits a white mercury compound on the silver image. The whitened image is afterwards blackened, or redeveloped, thus enhancing its density. The amount of intensification, or mercury deposit, is proportional to the density of the original silver image. In very thin areas the deposit will be practically negligible. This intensifier can be used to improve negatives that are fully exposed but underdeveloped. The results obtained with mercury intensifiers are less permanent than those obtained with either chromium or silver intensifiers. (See appendix A.)

Chromium intensifier is preferred when permanency is desired. The negative is bleached and then redeveloped in a nonstaining developer that does not contain an excess of sodium sulfite. The sulfite tends to dissolve the bleached image before the developing agent can act. The operation may be repeated for greater intensity. Because the degree of intensification becomes less with each subsequent treatment, little is gained from more than two treatments. Chromium intensifier will improve a thin, flat, or generally weak negative. Remember that only the areas containing a silver deposit will be intensified.

Silver intensifier is proportional in its action. It is equally suitable for positives and negatives because it does not change the color of the image. An acid solution of silver nitrate and a developing agent are used to precipitate silver on the silver of the image. The intensification is completed in one solution and is easily controlled. The degree of intensification depends to a great extent on the length of treatment, which should not exceed 25 min. (See appendix A.)

CHEMISTRY OF TONING

Toning is the process by which the color of a print or transparency is changed. By using various toning solutions and techniques almost any desired color can be obtained, but the discussion in this manual is limited to the production of a brown tone commonly known as sepia. Formulas for producing colors other than sepia are included in appendix A.

Sepia toning can be direct or indirect. In the direct processes the silver image is converted directly to silver sulfide, which is a sepia color. In the indirect processes a bleaching solution converts the silver image to silver bromide or silver chloride, which are yellow. The yellow is then changed to sepia by redevelopment in a solution of sodium sulfide. Two processes are in general use for direct sepia toning, the hypo-alum and the gold toner.

In the hypo-alum process a solution containing hypo, potassium alum (white), sodium chloride, and silver nitrate must be used at about 120 °F. New baths work best after ripening, which is usually accomplished by toning a few discarded prints. The lighter areas of the print tone first and the dark areas last. When the dark areas have turned from black to sepia, the toning is complete.

The gold toning process is similar to the hypo-alum process except that a small quantity of gold chloride is added to the toning bath. This permits more control in obtaining a greater variety of sepia tones through varying toning time.

In the indirect or redeveloping process, a two-solution process, the print is first bleached and then redeveloped. The sepia tone may be avoid by controlling the extent of the bleaching. If the blackened silver image is completely bleached, the final redeveloped tone will be a pure brown. If it is not completely bleached, the final tone will be brown-black, which may sometimes be desirable.

In all toning processes the final tone depends on the proper exposure and full development of the original black-and-white image. If the black silver image has been underdeveloped, the result will be a weak shade of sepia. The richer sepia tones are obtained only when the silver image has been completely developed. (See appendix A.)

NEGATIVE DEFECTS

ABRASION MARKS OR STREAKS

Appearance. - Fine, black lines usually resembling pencil scratches run in the same direction.

Cause. - Marks or streaks are formed by friction on the film emulsion caused by improper handling or storage at some time between its manufacture and development. These streaks may be readily produced by laying two films emulsion-to-emulsion and sliding one across the other when particles of dust are present between the sensitized surfaces.

Remedy. - Take great care in storing film and other sensitized material. Store boxes containing such supplies on end so that no pressure is exerted on the surface of the emulsion. Take care not to rub or drag a piece of sensitized material over a rough surface, either before or during development.

AIR BELLS

Appearance. - When an air bell occurs during development, it shows as a small transparent spot. Sometimes a minute, dark streak leads from the spot. When the negative is rocked in a tray, the streak projects from each side of the transparent spot in the direction the tray is rocked. If the tray is rocked in two directions, the streak will form a cross with the transparent spot in the center. When air bells occur in tank development, the dark streak usually forms at the lower edge of the transparent spot. When air bells occur in the fixing bath, they show as small, round, dark areas.

Cause. - The transparent spots that occur in the developer are caused by air bubbles on the emulsion surface, which prevent the developer from contacting the emulsion. The darkened streaks result from excess oxidation of the developer caused by the air in the bubbles. The dark spots that occur in the fixing bath are caused by a pocket of air holding the fixing bath away from the emulsion and allowing a slight continuation of development.

Remedy. - Immerse film carefully and thoroughly in the developing and fixing solutions; move film during development and fixation in order to break up and prevent air bells. Water always contains some air and, when the temperature rises, this air is expelled. It forms small bubbles on the inside of the tank and also adheres to the film surface during the preliminary stages of development. It may help if the water needed for development stands for several hours at the temperature required for use before developing operations start.

BLISTERS

Appearance. - Blisters on negatives resemble the familiar ones that arise on the human skin from slight burns.

Cause. - Blisters are caused by fluid or gas formed between the emulsion and the film support when the solution has become too warm and has loosened the gelatin from its support. They are also produced by a developer and fixing bath that are both strongly concentrated. In changing a film from one bath to the other, gas forms between the emulsion and the film support. Blisters are frequently caused by insufficiently rinsing the film after development and placing it directly into a fixing bath having strong acid content. Another common cause of blisters is allowing water from a faucet to flow directly onto the emulsion side of a negative.

Remedy. - The causes of blisters indicate the manner in which they may be avoided.

BLURRED NEGATIVE

Appearance. - A blurred negative is indistinct or lacks definition.

Cause. - The subject was not properly focused on the film, either the camera or the subject moved, or a portion of the film was not flat in the focal plane of the camera when the exposure was made. A blurred effect is sometimes produced by moisture or haze on the lens or by a dirty lens.

Remedy. - Take care in focusing and holding the camera. Keep the camera in proper adjustment and the lens free of moisture or dirt.

BROWN SPOTS

Appearance. - Brown or sepia-colored spots or small areas appear on the negative.

Cause. - Brown spots are produced by an oxidized developer or by fine chemical particles settling on the film before development. This defect may also occur during negative washing from rust or other impurities in the wash water.

Remedy. - Avoid an exhausted or oxidized developer. Do not mix chemicals in the developing laboratory. Filter the water used for washing. (See "SPOTS.")

CRYSTALLINE SURFACE

Appearance. - The surface of the negative emulsion has a crystalline appearance, suggesting frost on a window pane.

Cause. - Insufficient washing after fixing leaves hypo in the film to crystallize.

Remedy. - Be sure to do sufficient final washing.

DARK LINES

Appearance. - Dark lines fall into two distinct classes: those that run from the darker areas to the more transparent areas of the negative, and those that run from the more transparent areas to the darker areas. In both cases the lines are wider, not as clean cut, and not as nearly parallel as abrasion marks.

Cause. - The first class is caused by insufficient agitation of the negative during tank development. The cause of the second class is thought to be electrolytic.

Remedy. - The first class of dark lines can be prevented by agitating the negative more often during development, but this aggravates the defect in the second class. The only known remedy is to remove all the film hangers from the tank four or five times during the developing period, hold the hangers in a

bunch, and rest the corners of the hangers on the edge of the developing tank for 10 or 15 sec.

EXCESSIVE CONTRAST

Appearance. - In excessive contrast the highlights and even some of the halftones are greatly out of proportion in density to the shadows.

Cause. - Excessive contrast is caused by overdevelopment.

Remedy. - It can be prevented by proper development.

FADING TENDENCY

Appearance. - Sepia or yellow stains or areas appear in the negative.

Cause. - Fading is caused by incomplete fixation or insufficient washing. Remnants of the fixing bath left in the emulsion continue their action and in time this defect appears.

Remedy. - Always fix and wash the negatives fully and properly. Final washing is as important as any other operation in negative making.

FINGERMARKS

Appearance. - Imprints of fingers appear on the negative.

Cause. - Wet or greasy finger tips were impressed on the emulsion side of the film before or during development or fixation. If the mark is merely an outline of the finger, it was caused by water or grease on the finger; if dark, by the developer; and if transparent or light, by the fixing bath.

Remedy. - Keep your hands clean and dry when handling dry film. There is sometimes enough natural oil on finger tips to cause grease marks. Handle film by the edges. When your fingers have become wet with water or solution, wash and dry them before attempting to handle film. Keep your hands out of the fixing bath as much as possible, but whenever it becomes necessary to place them in the solution, always wash them thoroughly before handling the film.

FLATNESS

Appearance. - Flatness refers to insufficient contrast between the highlights, halftones, and shadows in a negative.

Cause. - Flatness in a negative usually results from underdevelopment, but the subject contrast or lighting may have been flat.

Remedy. - Continue development for the proper length of time to reproduce the contrast of the subject.

FOG

Fog is a deposit of silver that does not form part of the image. It may be very dense or only a slight veiling. It may occur on local parts or it may darken the entire negative. Fog increases the density and decreases the contrast of a negative. Fog may be aerial, dichroic, light, or chemical.

Aerial Fog

Appearance. - Slight veiling appears on the negative or parts of the negative.

Cause. - Aerial fog is caused by exposure to air during development, especially when hydroquinone is used as a reducing agent. It most frequently occurs in freshly mixed developers, especially those containing excessive amounts of hydroquinone or alkali. Developers containing formaldehyde or minute traces of copper or tin are also likely to cause aerial fog.

Remedy. - Use a desensitizer before development, add potassium bromide to the developer, or add used developer to fresher developer.

Dichroic Fog

Appearance. - Dichroic fog is usually of little density, consisting of finely divided particles of silver. When viewed by transmitted light, it is pinkish; when viewed by reflected light, it is a reddish-green.

Cause. - Dichroic fog is caused by using ammonia as an accelerator and by the presence of hypo or an excessive amount of sulfite in the developer.

Remedy. - Dichroic fog can easily be removed by treating the negative in a weak solution of potassium permanganate. Its prevention is obvious from its causes. Prevention is further ensured by using clean trays for the developer and the fixing bath.

FRILLING

Appearance. - Edges of the emulsion become detached from the base and either break off or fold over. When the latter happens, it is sometimes possible to smooth out the emulsion when the negative is placed to dry, partially remedying the damage.

Cause. - Frilling may be caused by careless handling, using solutions that are too warm, inadequate hardening of the emulsion due to insufficient fixation, using a spent fixing bath or one containing insufficient hardener, and excessive washing. Frilling is usually caused by the combination of careless or too frequent handling of the film and any mistake that will render the emulsion soft.

Remedy. - Handle film carefully and not too much; have all working solutions sufficiently cold and of proper freshness or strength. Wash film sufficiently, but never excessively.

GAS BELLS

Appearance. - Minute pimples or blisters appear on the negative.

Cause. - Transferring a negative from a strongly concentrated developer to a strongly acid fixing bath without first thoroughly rinsing the negative will form gas bells. In warm weather gas bells may appear in developing and fixing solutions of normal strength if the rinsing between development and fixation has been insufficient.

Remedy. - Use an intermediate hardener rinse bath.

HALATION

Appearance. - A dark bank or area extends from the negative record of intensely bright objects, suggesting a double image, and appears in the print as a halo or star of light around the object.

Cause. - Halation is caused by photographing an intensely bright object that is surrounded by dark objects. The intense light penetrates the emulsion and is reflected back by the negative support.

Remedy. - Use nonhalation film and avoid pointing the camera at bright sources of light.

LINES SUGGESTING LIGHTNING

Appearance. - Fine, opaque, forked, or branched lines resembling lightning appear in the negative.

Cause. - Charges of static electricity accumulating on the negative cause these lines. The static may be discharged while winding the film in the camera, while loading or unloading, or at any stage of processing. This defect is most common in roll films but may occur in cut film if the dark slide is pulled rapidly from the film holder.

Remedy. - Always wind and reel film slowly. Do not touch film with fingers when winding on reels for developing. Avoid dragging film over plush surfaces. Withdraw and replace dark slides slowly.

NEGATIVE TOO DENSE

Appearance. - A negative image composed of a too heavy silver deposit diminishes the normal or desired degree of transparency.

Cause. - A too dense negative is caused by overexposure, overdevelopment, or a combination of the two. In addition to the heavy image, there may be a veiling of fog produced by overdevelopment. (See "FOG.")

Remedy. - The proper degree of transparency for a negative is best found in making a print from the negative rather than merely looking at the negative as it is held in front of a light.

NEGATIVE TOO THIN

Appearance. - Insufficient silver deposit forming the negative image is apparent from the excessive degree of transparency.

Cause. - A too thin negative is caused by underexposure, underdevelopment, or a combination of the two.

Remedy. - Use proper exposure and development.

OPALESCENCE

Appearance. - The emulsion has a whitish appearance suggesting the color of an opal.

Cause. - Opalescence is caused by using alcohol to hasten the drying of an insufficiently washed film or lantern slide.

Remedy. - Return an opalescent film or slide to the fixing bath, allow it to remain in that solution until the opalescence has disappeared, and then thoroughly wash it. Note: Use denatured alcohol, diluted nine parts alcohol and one part water. This diluted solution will usually not cause opalescence.

PINHOLES

Appearance. - Minute transparent spots appear in negatives.

Cause. - Pinholes are caused by dust on the film before exposure.

Remedy. - Handle film properly.

PITMARKS

Appearance. - Fine holes or pits appear in the emulsion.

Cause. - Pitmarks are caused by excessive alum in fixing bath, sulfurous precipitation from the fixing bath when negatives are fixed in a tray, and too rapid drying of the negative.

Remedy. - Fix and dry properly.

PURPLE DISCOLORATION

Appearance. - A purple-colored stain appears on the negative.

Cause. - Purple discoloration is caused by high iron content in the water with which the chemicals were mixed. It also frequently occurs when negatives are allowed to stick together in the fixing bath so that fixation does not take place in the adhered areas and development continues even while the film is in the fixing bath. The spots caused by continuation in development are not a brilliant purple, but black with a purplish cast.

Remedy. - If practicable, filter thoroughly all water used for washing. A simple method of doing this is to tie felt or a good straining material over the faucets supplying the running water in which negatives are washed. Avoid impure water in mixing solutions. Negatives must be kept in motion in the fixing bath.

RETICULATION

Appearance. - Leatherlike graininess or wrinkling of the emulsion.

Cause. - Reticulation is caused by too great a difference in the temperature of the baths or between the final wash water and the air in which the negative is dried. The gelatin of the emulsion may become badly swollen in warm solution or wash water and upon shrinking will contract irregularly because of the metallic silver in the emulsion. Reticulation is also caused by excessive softening of the emulsion followed by a strong hardening bath or by a highly alkaline treatment followed by a strong acid bath.

Remedy. - Keep all solutions cool and at uniform temperature. Under tropical conditions, use a concentrated developer and short development. The reticulation effect may sometimes be removed by placing the negative in a 10 percent solution of formaldehyde for a few minutes and drying it in front of a fire. Use ample ventilation in drying negatives.

REVERSAL OF IMAGE

Appearance. - The image appears positive when the negative is examined by transmitted light.

Cause. - Reversal of the image is caused by extreme overexposure of the negative. This type of reversal is seldom encountered although quite often certain parts of the subject, such as street lights in exteriors or windows in interiors, will be reversed from overexposure.

Image reversal is also often caused by an unsafe darkroom lamp or by exposing the film to light during development and before fixing. The image that first develops serves as a negative, and on exposure to light an image is printed on the emulsion below, as in making a print. As development proceeds, the image produced is a positive.

Remedy. - Make your safelight safe; avoid developing too close to the safelight; and do not hold negatives too close to the safelight for prolonged view during development. Also make sure that the darkroom is light-tight.

SPOTS

Appearance. - Spots may be transparent, colored, opaque, or semiopaque, depending on their cause. They may be sharply defined or the edges may be soft and show a gradual blending to the normal color of the negative.

Cause. - White or transparent spots, indicating an absence of silver deposit, may be caused by dust on the film during exposure or development. The dust particles prevent the light or the developer from acting on the emulsion lying beneath them, and as the dust is washed off during fixing or washing, the film remains clear. An air bell may produce a spot. (See "AIR BELLS.") Floating chemical dust may settle on a film either before or after development. The chemical particles settling on the film before development may destroy its sensitiveness to light in the portions of the emulsion that they cover. Hypo dust will dissolve away a portion of the emulsion. To produce a white spot after development, the chemical must dissolve the silver. Thus, if particles of potassium ferricyanide adhere to a moist negative during drying, fine white spots having a coatlike tail will result.

Opaque, semiopaque, or black spots result from particles of grit or foreign matter on the negative or imbedded in the emulsion. Dust or particles of iron rust in the wash water will cling to the film during washing unless carefully wiped off. Particles of hydroquinone, pyro, Metol, and sodium carbonate settling on the film before development will cause more development to occur in these spots. If the chemical dust settles after development, stained spots may be formed. Any undissolved particles left in the developer on mixing or any fine crystals that settle out when the developer is cold will settle on the film during development and cause spots. Spots caused by undissolved particles settling on emulsions usually are round or oval with minute tails projecting from them. In tray development the tails often point in the direction in which the tray was rocked; in tank development they usually point downward.

Brilliant green, blue, or purple spots on negatives will often result from processing negatives in enamel trays where the enamel is chipped.

Remedy. - Keep the camera, magazine, and holder free of dust. Avoid mixing chemicals in the negative-making laboratory. See that all ingredients of a developer are dissolved before using the solution. Examine the developer to see that it is free of foreign particles and, if not, filter it before using. Use trays of proper size.

STREAKS

Appearance. - Streaks and patches, as in the case of spots, may be dark, white, or transparent. They are considered white if lighter than the surrounding area, and vice versa.

Cause. - Dark patches or streaks may be due to uneven development caused by not flowing the developer evenly over the film, by not rocking the tray, or by not moving the film in the developer. They may be due to a splash of developer on the film before developing, using a dirty tray or tank, using a fixing tray or tank for developing, or light fog. If the edges of the film are clear, the trouble is in the camera; if fogged, it is due to manipulation in the darkroom. Certain kinds of resinous woods and varnishes will cause dark fog patches. White or transparent patches may be due to an obstruction in the camera that prevented the light from acting on the plate, a "resist" in the form of oil or grease that prevented the action of the developer, a splash of hypo, or touching the film with hypo-soaked fingers before development. The hypo dissolves away more or less of the emulsion so that, on developing, the portion touched appears lighter than the rest. Drying marks in the form of

teardrops or white patches are caused by splashes of water on a dry negative or by leaving spots of water on the film before drying, especially if the film is dried in warm air.

Remedy. - The precautions to be taken to avoid streaks suggest themselves when the cause of the streak is traced. Usually streaks can be avoided by care in operations and in maintaining apparatus. When placing a negative to dry, always blot excessive moisture from both sides. After negatives have dried for a few minutes, remove teardrops with a clean cloth or chamois.

UNEVEN DEVELOPMENT

Appearance. - A streak or area has different density than the remainder of the negative.

Cause. - Uneven development is caused by failure to immerse the entire surface of the film simultaneously, allowing two films to adhere while in the developer, or not keeping the film in movement by rocking the tray or reversing the tank during development.

UNEVEN EMULSION

Appearance. - The thickness of the emulsion varies.

Cause. - Uneven emulsion is caused by faulty manufacture in that the emulsion was not evenly coated over the entire surface of the film.

Remedy. - Return sensitized material to the manufacturer for replacement, enclosing film in the original box or at least giving the manufacturer's emulsion number. This defect is rarely encountered.

UNEVEN FIXATION

Appearance. - The density of the negative varies.

Cause. - The cause of uneven fixation is similar to that of uneven development except that the defect occurs during fixation instead of during development.

WHITE DEPOSIT

Appearance. - White granular deposit appears on the surface of the negative.

Cause. - White deposits are caused by exhausted or improperly prepared fixing bath. A sulfur sediment is deposited over the negative surface and whitens when the negative is dried.

Remedy. - Replace the fixing bath; swab the emulsion side of the negative before placing to dry.

YELLOW STAINS

Appearance. - Areas of the negative are colored yellow.

Cause. - The commonest yellow stains are oxidation and silver stains. These are due to weak or decomposed fixing baths; slightly oxidized or exhausted developer; failure to rinse the negative between development and fixation; uncleanliness, dirty trays, or impurities carried into the developer from the hands; hypo or fixing bath in the developer; insufficient washing; excessive carbonate in the developer; or leaving the negative insufficiently covered in the fixing bath. The area insufficiently covered is fixed only as far as the first stage and, on exposure to the air, reveals a yellow stain.

PRINT DEFECTS

ABRASION MARKS OR STREAKS

Cause. - Abrasion marks or streaks result from friction on the paper emulsion caused by improper storage or handling.

Remedy. - Always handle sensitized photographic paper with the utmost care. When cutting large sheets of sensitized paper to smaller sizes, place two sheets together, emulsion to emulsion, thereby protecting the sensitized surfaces from contact with the papercutter. The paper should be kept on edge in a cool, dry storage place and never handled roughly. Adding a small amount of potassium iodide to the developer (not exceeding one-eighth of a grain to each ounce of working solution) will generally eliminate abrasions. Use potassium iodide only when necessary.

AIR BELLS

Cause. - Spots result when air bubbles form on the print surface during development, thus preventing the solution from reaching the emulsion covered by them. The spots will be white if the bubbles are formed in the developer and discolored if they are formed in the fixing bath.

Remedy. - Immerse the sheet of paper in the developer with a sliding movement - emulsion side up - as quickly and evenly as possible. Always have plenty of developer in the tray.

BAD DEFINITION - BLURRED SPOTS

Causes. - If the negative and paper are not in perfect contact, blurred spots will form. In projection printing bad definition can be caused by poor focusing, vibration, or excessive magnification.

Remedy. - If the contact printer has a pneumatic platen, the air cushion must be sufficiently inflated. If the printer top is constructed with a felt or sponge rubber pad, the hinge must be adjusted to ensure even pressure on the printer glass when the platen is in the printing position. Check focusing; make the enlarger more stable or eliminate vibrations; do not enlarge negatives excessively.

BLISTERS

Causes. - Anything that will cause a slight rupture of the emulsion surface may form a blister. Softening of the emulsion, caused by insufficient hardener in the fixing bath, allows the gelatin to become separated from its paper base. Other causes are too great a change in temperature between the different processing baths and allowing water to run directly on the print from the faucet with excessive force.

Remedy. - Do not allow water from a faucet to be directed on any one spot of the print. Use a correctly prepared acid hardening-fixing bath. It is good practice to use two fixing baths - one to do the preliminary fixing and one fresh or slightly used to finish the process. Keep all solution as nearly even in temperature as possible.

BLURRED PRINT

Cause. - A print made from the back of a film negative will be slightly blurred. If only the edges of the print are blurred, the printing mask is too thick, thereby preventing proper contact between the negative and the sensitized paper.

Remedy. - Maintain the emulsion side of the negative in perfect contact with the emulsion side of the sensitized paper; otherwise there will be a lack of sharp definition in the print. Use thin, opaque material for masking the negative.

BROWN SPOTS AND STAINS

Causes. - Brown spots and stains are caused by rust coming into contact with the emulsion surface, chemical dust in the laboratory settling on the paper surface, exhausted or oxidized developer, and weak acid content in the fixing bath. It can also result from removing prints from the developer and handling them too much before the developing action is stopped, not using an acid short stop, or insufficient rinsing in the water between development and fixation.

Remedy. - When the cause has been determined, the remedy will be evident.

FADING TENDENCY

Causes. - Incomplete fixation, resulting in light affecting the silver halide that has not been entirely removed from the emulsion, will cause fading. Another cause is prolonged immersion in a fixing bath that is nearing exhaustion and has become overcharged with silver. A third cause is insufficient washing, permitting hypo to remain in the emulsion. This action is gradual but will be hastened in a damp climate.

Remedy. - When the cause has been determined, the remedy will be evident.

FINGERMARKS

Cause. - Fingermarks on prints result from wet, moist, or chemically contaminated fingers.

Remedy. - Bathe hands in cold water and dry them thoroughly with a clean towel before handling sensitized materials.

FLATNESS

Flatness is caused by use of the wrong contrast of paper for the particular negative and underdevelopment.

FOG

The causes of fog are incorrect safelight, light are striking the paper, paper that has passed the expiration date of the emulsion, paper that has been exposed to chemical fumes, prolonged development, especially at high temperature, and improperly prepared or contaminated developer.

FRILLING

Careless handling in processing, solutions that are too warm, a weak fixing bath, or an insufficient amount of hardener can cause frilling.

GREENISH-BROWN TONES

Causes. - Greenish-brown tones are caused by underdevelopment at the recommended time resulting from overworked developer, overly diluted developer, too low a temperature, overexposure and underdevelopment, excessive potassium bromide, and contaminated developer.

Remedy. - Develop according to manufacturer's specifications.

MUDDY TONES

Muddy tones are caused by overexposure, insufficient development, dampness, exposure of the paper to chemical fumes, and outdated paper.

PRINTS TOO DARK

Prints may become too dark because of overexposure, overdevelopment, or both or from insufficient bromide in the developer, resulting in too rapid development.

PRINTS TOO LIGHT

Causes. - Underexposure, underdevelopment, or both causes prints to be too light.

Remedy. - Determine cause and make new print.

PURPLE DISCOLORATION

Purple discoloration can be caused by improper fixation, failure to move prints sufficiently during the first minute in the fixing bath, not completely immersing prints in the fixing bath, and allowing prints to float, emulsion side up, on top of the fixing bath.

WHITE SPOTS

Causes. - White spots are caused by foreign matter adhering to the paper or negative, preventing exposure in those areas.

Remedy. - Keep all surfaces clean.

BLACK SPOTS

Causes. - Black spots will appear in a print made from a negative that has pinholes.

Remedy. - Spot out pinholes in the negative before printing.

UNEVEN DEVELOPMENT

Causes. - Improper immersion of print in the developer, insufficient agitation, and failure to continuously agitate the developer can cause uneven development.

Remedy. - Immerse the exposed paper entirely and quickly in the developer. Agitate during the entire development time.

UNEVEN FIXATION

Causes. - Uneven fixation results from failure to move prints frequently while they are in the fixing bath, prints sticking together, air bells on the surface of the print (rare), and prints floating on the surface of the fixing bath.

Remedy. - Move prints frequently to avoid air bells and ensure proper fixation.

WATER SPOTS

Causes. - Water spots are generally a result of hanging the negatives improperly for drying or handling negatives when they are drying.

Remedy. - Hang negatives so that water will flow continuously from the negatives in one direction.

YELLOW STAINS (SOMETIMES BROWNISH-YELLOW)

Weak or exhausted fixing bath, weak or oxidized developer, or forcing development will frequently produce yellow oxidation stains. Failure to rinse prints properly between development and fixation will generally cause stains by allowing the surplus developer to continue its action in the fixing bath. Yellow stains are also caused by uncleanliness and poor processing methods, insufficient washing, and examining a print by white light before it is fixed sufficiently to prevent further reduction of the silver halide.

GENERAL CHEMICALS AND RAW MATERIALS

ACETONE, $(CH_3)_2CO$

French, acetone; German, Aceton

Synonyms: dimethyl-ketone; ketopropane; methylacetal; propanone; pyroacetic ether

Atomic weight, -------- Molecular weight, 58
Boiling point, 56.48 °C Specific gravity, ~0.798°
Melting point, 94.3 °C

Solubility: soluble in water, alcohol, and ether

Properties: colorless liquid with mint-like odor; highly volatile and flammable. Should be kept in well-stoppered bottles in a cool place.

Derivation: by dry distillation of calcium acetate; also as a byproduct in the manufacture of butyl alcohol; purified by rectification

Grade: technical; USP (98 percent acetone). Should not show more than a trace of acidity.

Uses in photography: Acetone is a solvent for resins, collodion, and nitrocellulose; is used in manufacture of sheet celluloid, varnishes, and film cements; and can be used as a substitute for the alkali in pyro or hydroquinone developers. The acid amidol developer can be remarkably energized by the addition of from 3 to 5 percent acetone.

ACETONE SULFITE, $NaHSO_3(CH_3)_2COH_2O$

French, acetone sulfite; German, Acetonsulphit

Synonyms: ------

Atomic weight, ------ Molecular weight, 162
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; slightly soluble in alcohol

Properties: fine white powder

Derivation: by combining acetone with acid sodium sulfite

Grade: ------

Uses in photography: Acetone sulfite is a substitute for sodium sulfite and the metabisulfites in development. Ten parts acetone sulfite is equal to 7.5 parts of potassium metabisulfite or 20 parts of dry sodium sulfite. As a preservative of pyro 0.50 oz of acetone sulfite is added for each ounce of pyro used. It keeps fixing baths clear and colorless.

ACID ACETIC, $HC_2H_3O_2$

French, acide acetique; German, Essigsäure

Synonyms: acid methanecarboxylie; vinegar acid; purified pyroligneous acid

Atomic weight, ------ Molecular weight, 60
Boiling point, 118.1 °C Specific gravity, ------
Melting point, 16.7 °C

Solubility: soluble in water, alcohol, ether, chloroform, and glycerine

Properties: colorless liquid with sour pungent smell; vapor flammable; congeals at 15.65 °C

Derivation: by destructive distillation of wood; also by oxidation of dilute ethyl alcohol, governed by bacterial action

Grade: Two grades are commonly used in photography. Glacial acetic acid, USP (99 percent acetic acid), with a specific gravity of about 1.065, congeals at about 12.8 °C. Hence the name "glacial (or icelike) acetic acid." Commercial grade (28 percent acetic acid) has a specific gravity of 1.038. This strength acid can be easily prepared from the glacial acid by dilution with distilled water. Glacial acetic acid is a strong escharotic, if spilt on the skin, it should be washed off at once. The impurities often found in acetic acids are sulfurous acid, tarry matters, and hydrochloric or sulfuric acid. Samples that yield a precipitate when a drop of silver nitrate solution is added to a quarter of an ounce, or that discolor when the mixture is exposed to light, should be rejected.

Uses in photography: Acid acetic is used to prepare acid fixing baths and as a clearing bath after ferrous oxalate development of bromide paper. Used in the uranium toning bath it facilitates the penetration of the gelatine by the bath. It is a solvent for gelatine, celluloid, and pyroxyline and is used in the manufacture of cellulose acetate and the preparation of gelatine substratum.

ACID BENZOIC, C_2H_3COOH

French, acide benzoique; German, Benzoesäure

Synonyms: acid phenylformic

Atomic weight, ------ Molecular weight, 122
Boiling point, 249.2 °C Specific gravity, 1.2659
Melting point, 121.25 °C

Solubility: soluble in alcohol and ether; slightly soluble in water; freely soluble in chloroform or benzene

Properties: white voluminous crystalline plates or needles with aromatic odor

Derivation: by sublimation from gum benzoin; industrially, by chlorinating toluol (heating toluol under pressure with milk of lime), distilling off the benzoic acid by steam, and crystallizing it.

Grade: USP (from benzoin)

Uses in photography: Acid benzoic has been used as a preservative in photographic emulsions, in toning baths, and for sizing and surfacing photographic paper.

ACID BORIC, H_3BO_2

French, acide borique; German, Borsäure

Synonyms: acid boracic; acid orthoboric

Atomic weight, ------ Molecular weight, 62
Boiling point, ------ Specific gravity, 1.4347
Melting point, 184 °C

Solubility: soluble in water, alcohol, glycerine, and volatile oils

Properties: white shining scales or amorphous powder

Derivation: by adding hydrochloric or sulfuric acid to a solution of borax and crystallizing

Grade: USP (crystal or powder)

Uses in photography: Acid boric is used in pyro developers as a restrainer and to prevent stains and can also be used in the fixing bath as a stain

preventer. A solution of 1 part boric acid in 30 parts of water acts as a stop bath, stopping development instantly.

ACID CARBOLIC (PHENOL), C_2H_3OH

French, acide phenique; German, Karbolsäure

Synonyms: phenic acid; phenyl hydrate; hydroxybenzene

Atomic weight, ------ Molecular weight, 94
Boiling point, 182.6 °C Specific gravity, 1.0677
Melting point, 42.5 °C

Solubility: soluble in water, alcohol, ether, chloroform, glycerine, and alkalis

Properties: white crystalline mass, turns pink or red if not pure; absorbs water from the air and liquefies; has sharp burning taste and distinctive odor; is a strong, corrosive poison

Derivation: by boiling coal tar oil fraction between 170 and 230 °C with caustic soda to form phenolate. The solution is purified by removing the naphthalene and treated with acid to free the phenol, which is further purified by distillation. It can also be prepared by converting benzol into sulfonic acid and fusing the latter with caustic soda. On treating the sulfonate with acid, pure phenol is released.

Grade: USP (crystal or fused)

Uses in photography: Acid carbolic is used as a preservative for photographic emulsions, gelatine solutions, and mountants. It is the starting point of many photographic chemicals, developers, and dyes.

ACID CHROMIC (ANHYDRIDE), CrO_3

French, acide chromique; German, Chromsäure anhydrid

Synonyms: chromium trioxide

Atomic weight, ------ Molecular weight, 100
Boiling point, ------ Specific gravity, 2.67
Melting point, 196 °C

Solubility: soluble in water

Properties: reddish-brown crystals; violently explodes when brought into contact with organic substances; highly poisonous

Derivation: by adding hydrochloric or sulfuric acid to a solution of sodium bichromate and recovering the product by recrystallization

Grade: chemically pure

Uses in photography: The principal use of acid chromic is in the fish glue process. It is used in conjunction with sulfuric acid for clearing the fish glue image before to etching and for removing any scum from between halftone dots.

ACID CITRIC, $(CO_2HCH_2)_2C(OH)CO_2H$

French, acide citrique; German, Citronensäure

Synonyms: acid oxytricarballylic

Atomic weight, ------ Molecular weight, 210
Boiling point, ------ Specific gravity, 1.542
Melting point, 153 °C

Solubility: soluble in water, alcohol, and ether

Properties: colorless, odorless crystals with characteristic lemon flavor

Derivation: Crude citric acid is obtained from lemons or other citrus fruit and is neutralized with calcium carbonate. The lime salt is dissociated with sulfuric acid. The product is then filtered, evaporated, and recovered by crystallization. Tartaric acid is the most likely impurity.

Grade: USP (crystal or powder)

Uses in photography: Citric acid can be used as a preservative in some developing solutions and as a restrainer in others. It can be used for making acid fixing baths and as preservative in emulsions. One part of citric acid to 100 parts of water is an excellent clearing bath for removing the yellow pyro stain from negatives. Citric acid is used in preparing gelatino-citro-chloride printing-out paper. Citric acid can replace acetic acid in photographic solutions. One ounce of citric acid is equivalent to 2 oz of 28 percent acetic acid. Citric acid will replace glacial acetic acid weight for weight.

ACID DIGALLIC (TANNIN), C H O

French, acide tannique; German, Gerbsäure

Synonyms: acid gallotannic

Atomic weight, ------ Molecular weight, 322
Boiling point, ------ Specific gravity, ------
Melting point, decomposes at 210 °C

Solubility: soluble in water and alcohol; slightly soluble in ether

Properties: lustrous, faintly yellow, amorphous powder

Derivation: by extraction from powdered gall nuts with water and alcohol; then evaporated and purified by crystallization

Grade: USP

Uses in photography: Acid digallic is principally used in process work as an ingredient in the etching solution for collotype plates, acting as a hardener of the gelatine. It has been recommended as a hardening agent for prints and negatives but is likely to give some stain.

ACID FORMIC, $HCOOHH_2CO_3$

French, acide formique; German, Ameisensäure

Synonyms: acid hydrogen carboxylic

Atomic weight, ------ Molecular weight, 46
Boiling point, 100.8 °C Specific gravity, 1.2178
Melting point, 8.3 °C

Solubility: soluble in water, alcohol, and ether

Properties: colorless liquid with pungent odor; very strongly caustic

Derivation: by dissociation of sodium formate with mineral acid; then by distillation and absorption in distilled water; purified by rectification

Grade: USP (75 percent)

Uses in photography: Acid formic is comparatively unimportant in photography but is sometimes used in process work instead of acetic acid for stripping wet collodion negatives. Its disadvantage is its dangerous caustic properties.

ACID GALLIC, CH(OH)COHHO(3:4:5)

French, acide gallique; German, Gallussäure

Synonyms: acid trioxybenzoic; acid trihydroxybenzoic

Atomic weight, ------ Molecular weight, 188.06
Boiling point, ------ Specific gravity, 1.694
Melting point, 220 to 240 °C

Solubility: soluble in alcohol; slightly soluble in water and ether

Properties: slightly yellow or colorless crystalline needles or prisms

Derivation: by fermentation from powdered galls or by boiling tannin with dilute acid or caustic soda

Grade: USP

Uses in photography: Acid gallic is not very much used in modern photography. In the early days of photography it was used as a developer for paper negatives. At present it is occasionally used in the development of printing-out paper intensification of collodion and gelatine negatives and as one of the ingredients in the ferrous citrate developer for chloride plates. Acid gallic is used by lithographers to prepare the surface of zinc plates for printing.

ACID HYDROBROMIC, HBr IN AQUEOUS SOLUTION

French, acide bromhydrique; German, Bromwasserstoffsäure

Synonyms: hydrogen bromide; bromhydric acid

Atomic weight, ------ Molecular weight, 81
Boiling point, ------ Specific gravity, 1.38
Melting point, ------

Solubility: soluble in water

Properties: faintly yellow or clear colorless liquid

Derivation: by passing hydrogen with bromine vapor over a warm platinum sponge, which acts as a catalyzer, and then collecting it by absorption in water

Grade: USP (40 percent)

Uses in photography: Acid hydrobromic is used in the production of some of the bromides used in photography and is sometimes added to emulsions as a preservative. Small additions of hydrobromic acid will cure fog in an emulsion while decreasing the emulsion speed.

ACID HYDROCHLORIC, HCl

French, acide chlorhydrique; German, Chlorwasserstoffsäure

Synonyms: muriatic acid; hydrogen chloride

Atomic weight, ------ Molecular weight, 36.5
Boiling point, ------ Specific gravity, 1.16
Melting point, ------

Solubility: soluble in water; miscible in all proportions with alcohol and water

Properties: clear and colorless or slightly yellow fuming, pungent liquid; poisonous

Derivation: usually by the action of sulfuric acid on common salt; also as a byproduct of the LeBlanc soda process

Grade: USP (33 percent)

Uses in photography: Acid hydrochloric is generally used as a clearing bath for pyro stains and as a clearing bath in the platinotype process. It is used in connection with the vanadium, iron, and copper toning processes. Adding HCl to chloride emulsions increases speed and tends to make such emulsions clean working and free from fog.

ACID HYDROFLUORIC, HF

French, acide fluorhydrique; German, Fluorwasserstoffsäure

Synonyms: hydrogen fluoride; fluoric acid

Atomic weight, ------ Molecular weight, 20
Boiling point, ------ Specific gravity, ------
Melting point, ------
Solubility: ------

Properties: clear, colorless fuming corrosive liquid; very dangerous to handle; dissolves the nails and produces terrible sores if allowed to come in contact with the skin

Derivation: by treating calcium fluoride with sulfuric acid and distilling the mixture in a platinum retort. Hydrofluoric acid gas passes over and is dissolved in distilled water.

Grade: technical (52 percent)

Uses in photography: The principal use of acid hydrofluoric in photography is for stripping films from glass plates; a 2 to 3 percent solution being used. It is also used in hyalography or photographic etching on glass.

ACID LACTIC, CHCH(OH)COOH

French, acide lactique; German, Milchsäure

Synonyms: acid alpha-hydroxypropionic and acid ethylidenelactic

Atomic weight, ------ Molecular weight, 90
Boiling point, ------ Specific gravity, 1.2485
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: yellow or colorless thick liquid

Derivation: very largely from sugar by lactic fermentation

Grade: USP (75 percent)

Uses in photography: Acid lactic is occasionally used in preparing silver lactate positive emulsions. It acts as a preservative for slow chloride emulsions, prevents fog, and is a useful preservative for amidol developer in the

proportion of 5 cm^3 lactic acid to 1000 cm^3 developer. A 3 percent solution can be used as a stop bath for arresting development.

ACID NITRIC, HNO

French, acide nitrique; German, Salpetersäure

Synonyms: aqua fortis; hydrogen nitrate; acid azotic

Atomic weight, ------ Molecular weight, 63.02
Boiling point, 86 °C Specific gravity, 1.42
Melting point, ------

Solubility: soluble in water and alcohol

Properties: transparent, colorless, fuming, suffocating, caustic, and corrosive liquid; causes very painful burns

Derivation: by distillation from saltpeter and sulfuric acid

Grade: USP

Uses in photography: Nitric acid is the principal ingredient in the nitration of cotton for nitrocellulose. It is used as a preservative in pyro developer, in the production of silver nitrate, and in some of the vanadium or iron toning baths. In process work nitric acid is largely used as a mordant for etching zinc.

ACID OXALIC, $COHCOH_2HO$

French, acide oxalique; German, Oxalsäure

Synonyms: ------
Atomic weight, ------ Molecular weight, 126.05
Boiling point, ------ Specific gravity, 1.653
Melting point, 187 °C

Solubility: soluble in water, alcohol, and ether

Properties: transparent, colorless crystals; poisonous

Derivation: Sodium carbonate heated under pressure with carbon dioxide produces sodium formate, which heated with sodium carbonate yields sodium oxalate. A calcium salt is added to precipitate calcium oxalate, which, when treated with sulfuric acid, gives oxalic acid.

Grade: chemically pure

Uses in photography: Acid oxalic is used in sensitizing platinotype paper, as a preservative for pyro developer, and in preparing ferrous oxalate developer. It is used for making corrections on blueprints because it dissolves the Prussian blue image. With some developers oxalic acid acts as a restrainer.

ACID PHOSPHORIC, H_3PO_4

French, acide phosphorique; German, Phosphorsäure

Synonyms: orthophosphoric acid

Atomic weight, ------ Molecular weight, 98.06
Boiling point, ------ Specific gravity, 1.750
Melting point, 38.6 °C

Solubility: miscible in all proportions with water and alcohol

Properties: clear, colorless, syrupy liquid

Derivation: by oxidizing white phosphorous, first in air and then with nitric acid, and evaporating the solution

Grade: USP (85 to 88 percent)

Uses in photography: A 20 percent solution of phosphoric acid is frequently employed for acidulating platinum toning baths and preparing silver phosphate emulsions.

ACID PICRIC, CH(NO)OH

French, acide picrique; German, Pikrinsalpeters

Synonyms: acid picronitric; trinitrophenol

Atomic weight, ------ Molecular weight, 229.05
Boiling point, ------ Specific gravity, 1.767
Melting point, 122 °C

Solubility: soluble in water, alcohol, and ether

Properties: yellow crystals; very poisonous and highly explosive, especially when in contact with metals or metallic oxides

Derivation: by nitration of monochlorobenzol in the presence of sulfuric acid

Grade: USP

Uses in photography: Acid picric in used in preparing nonhalation plates and sometimes for making color filters.

ACID SALICYLIC, CH(OH)(COOH)

French, acide salicylique; German, Salicilsäure

Synonyms: acid ortho-hydroxybenzoic

Atomic weight, ------ Molecular weight, 138
Boiling point, ------ Specific gravity, 1.483
Melting point, 156 °C

Solubility: soluble in alcohol and ether; slightly soluble in water

Properties: white crystals

Derivation: by adding hydrochloric acid to a solution of sodium salicylate and then filtering, drying, and purifying by sublimation

Grade: USP

Uses in photography: Acid salicylic is used as a preservative in emulsions and mounting paste.

ACID SULFURIC, H_2SO_4

French, acide sulfurique; German, schwefel Säure

Synonyms: oil of vitriol

Atomic weight, ------ Molecular weight, 98.09
Boiling point, 210 to 338 °C Specific gravity, 1.84
Melting point, 10.46 °C

Solubility: soluble in water with evolution of heat

Properties: strongly corrosive, dense, oily, liquid; colorless when pure. It is intensely corrosive and chars all organic matter it comes in contact with. In mixing always add the acid slowly to the water, not the water to the acid.

Derivation: made by the Chamber process by roasting pyrites or sulfur in specially designed furnaces or by the catalytic process using sulfur dioxide from pyrites or sulfur and oxygen from the air to produce sulfur trioxide, which is absorbed in water to yield sulfuric acid. The catalyzers most in use are spongy platinum and iron oxide. Purified by distillation.

Grade: USP

Uses in photography: Acid sulfuric is sometimes used as a preservative in pyro developer. It is also used with nitric acid to prepare nitrocellulose. It is one of the ingredients in the various permanganate, persulfate, and bichromate of potassium bleaching and reducing solutions.

ACID SULFUROUS, H_2SO_3

French, acide sulfureux; German, schweflige Säure

Synonyms: sulfur dioxide; sulfurous anhydride; hydric sulfite

Atomic weight, ------ Molecular weight, 83
Boiling point, ------ Specific gravity, 1.025
Melting point, ------

Solubility: soluble in water

Properties: colorless liquid with suffocating sulfur odor

Derivation: Pyrites are calcined, the gas is absorbed in water, and the liquor is then concentrated in a still.

Grade: USP (6 percent)

Uses in photography: Acid sulfurous is sometimes used as a preservative for pyro developer and to acidify the fixing bath. It must be freshly prepared as it quickly changes into sulfuric acid.

AGAR-AGAR

French, agar-agar; German, Agar-Agar

Synonyms: Japanese gelatine; Chinese isinglass

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------
Solubility: ------

Properties: transparent strips similar in appearance to shredded gelatine

Derivation: Agar-agar is a gelatinous vegetable material made from several of the white sea weeds (gracilara lichenoides and eucheuma spinosum). These sea weeds are found principally in the Pacific and Indian Oceans and the Japan Sea.

Grade: USP

Uses in photography: Agar-agar has been used at different times as a substitute for gelatine in emulsions. It is, however, more difficult to melt than gelatine and a good deal harder to handle. It has been used as a substitute for arrowroot in preparing silver paper. In process work agar-agar is sometimes used as a substitute for fish glue in preparing the resist for etching.

ALBUMEN

French, albumine; German, Albumen

Synonyms: ------
Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: almost colorless, gummy liquid that dries to a pale yellow solid; similar looking to many of the gums

Derivation: an exceedingly complex organic compound obtained from blood, milk, or eggs. In photography, only the egg albumen is used. This is prepared by separating the fresh white of egg from the yolk, diluting with water, beating to a froth, filtering, and evaporating. Albumen is coagulated by heat at 65.5 °C. It is also coagulated by alcohol and most inorganic salts. It is easily decomposed and must be used directly after preparation, otherwise a preservative must be added.

Grade: technical

Uses in photography: Albumen is used in preparing albumenized paper and in various positive processes. It is used as a substratum in process work and in conjunction with potassium bichromate for sensitizing zinc plates in photo-etching. Albumen clarifies gelatine solutions.

ALCOHOL ETHYL, CHOH

French, alcool ethylique; German, aethylalkohol

Synonyms: grain alcohol; fermentation alcohol; cologne spirits; spirits of wine; ethyl hydrate

Atomic weight, ------ Molecular weight, 46
Boiling point, 78.4 °C Specific gravity, 0.785
Melting point, -112.3 °C

Solubility: soluble in water, methyl alcohol, and ether

Properties: colorless, volatile liquid with a vinous odor

Derivation: fermentation of the sugars derived from starch

Grade: cologne spirits containing 95 to 96 percent alcohol

Uses in photography: Alcohol ethyl is used in preparing collodion and sometimes in manufacturing celluloid. It is frequently added to photographic emulsions, where it acts as a preservative. When present at the time of emulsification, alcohol ethyl has considerable influence on the formation of the silver halide grain, keeping it fine and uniform.

ALCOHOL METHYL, CH_2OH

French, alcool methylique; German, methyl Alkohol

Synonyms: wood alcohol; wood naphtha; methyl hydrate; Columbian spirits

Atomic weight, ------ Molecular weight, 32
Boiling point, 66.78 °C Specific gravity, 0.7913
Melting point, -97.8 °C

Solubility: soluble in water, alcohol, and ether

Properties: colorless, volatile liquid; highly poisonous

Derivation: by the destructive distillation of wood; purified by rectification

Grade: USP

Uses in photography: Alcohol methyl is one of the solvents frequently used in manufacturing celluloid. It is an excellent solvent for resins, is sometimes used to prepare very concentrated solutions of developers, and is used for denaturing ethyl alcohol. Using it in connection with photographic emulsions is dangerous because it produces fog.

ALUM-AMMONIA, $Al_2(SO)(NH)SO24H_2O$

French, alun d'ammoniaque; German, Ammoniakalaun

Synonyms: aluminum-ammonium sulfate

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, 1.645
Melting point, 94.5 °C

Solubility: soluble in water; insoluble in alcohol

Properties: colorless crystals

Derivation: by crystallization from a mixture of aluminum and ammonium sulfates; purified by recrystallization

Grade: USP (lump ground or powdered)

Uses in photography: Alum-ammonia is used in preparing acid fixing baths and sometimes as a hardener for gelatine.

ALUM CHROMIUM, $K_2SO_4Cr_2(SO_4)24H_2O$

French, alun de chrome; German, Chromalaun

Synonyms: chromium sulfate; potassium sulfate

Atomic weight, ------ Molecular weight, 916
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol and ether

Properties: violet crystals yielding a dichroic solution

Derivation: a byproduct in the manufacture of alizarine and several other dyes

Grade: technical (crystal or powdered)

Uses in photography: Chromium alum is generally used as a hardener for photographic emulsions, the addition being made before coating. It is also used in preparing the chromium alum fixing bath. In process work chromium alum is used as a hardening agent for gelatine and fish glue and is added to the nitric acid bath for etching enamel images on zinc to prevent the image from becoming soft.

ALUM-IRON AMMONIA, $FeNH(SO)12H_2O$

French, alun de fer; German, Ammoniakeisenalaun

Synonyms: ammonio-ferric sulfate, iron ammonia sulfate

Atomic weight, ------ Molecular weight, 962
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: lilac or violet efflorescent crystals

Derivation: Solutions of ferric sulfate and ammonium sulfate are mixed, evaporated and crystallized, and purified by recrystallization.

Grade: USP

Uses in photography: Alum-iron ammonia has been recommended for use in fixing baths but is not satisfactory. Its principal use in photography is in the making of ferric oxalate.

ALUM POTASH, $Al_2(SO_4)_3K_2SO_424H_2O$

French, alun de potasse; German, Kalialaun

Synonyms: aluminum sulfate; potassium sulfate

Atomic weight, ------ Molecular weight, 948
Boiling point, ------ Specific gravity, 1.7571
Melting point, 105 °C

Solubility: soluble in water; insoluble in alcohol

Properties: white crystals

Derivation: by roasting alunite in special furnaces and afterwards leaching the mass and recovering the salt by crystallization

Grade: USP

Uses in photography: Alum potash is used in preparing hardening solutions for fixing baths. It is one of the ingredients of the hypo alum toning bath and can be used as a clearing bath. In process work alum potash is used in conjunction with dilute nitric acid for matting the surface of zinc plates before

coating them with bichromated albumen. It is sometimes used for hardening photographic emulsions but is not so suitable as chromium alum.

ALUMINUM, Al

French, aluminium; German, Aluminium

Synonyms: ------

Atomic weight, ------ Molecular weight, 27
Boiling point, ------ Specific gravity, 2.708
Melting point, 657 °C

Solubility: soluble in acids and alkalies; insoluble in water

Properties: silvery, ductile metal

Derivation: by electrolysis of the oxide in a bath of molten cryolite

Grade: sheet and dust

Uses in photography: Aluminum is frequently used as one of the ingredients in flashlight powders. It is used extensively for light hand cameras and lens fittings. It is also used for the screen and plate holders of process cameras because it is not easily acted upon by silver nitrate solutions. Aluminum is now used as a substitute for lithographic stone.

ALUMINUM CHLORIDE, $Al_2Cl_4 12H_2O$

French, chlorure d'alumine; German, Chloraluminium

Synonyms: ------

Atomic weight, ------ Molecular weight, 483
Boiling point, ------ Specific gravity, ------
Melting point, 190 °C

Solubility: soluble in water, ether, and alcohol

Properties: yellowish-white crystalline or granular powder; very deliquescent. Must be kept in well-stoppered bottles.

Derivation: by passing chlorine gas over alumina in a heated tower; recovered by sublimation

Grade: technical

Uses in photography: aluminum chloride is used in gold and platinum toning baths. It has been recommended for hardening gelatine emulsions but is not satisfactory.

ALUMINUM SULFATE, $Al_2(SO_4)_3 18H_2O$

French, sulfate d'alumine; German, Aluminiumsulfat

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: ------

Derivation: ------

Grade: ------

Uses in photography: Aluminum sulfate is of very little importance in photography. This material is often erroneously called alum.

ALUMINUM SULFOCYANIDE, $Al(CNS)_3$

French, Sulfocyanure d'alumine; German, Aluminium-rhodanid

Synonyms: aluminum sulfocyanate; aluminum-rhodanide

Atomic weight, ------ Molecular weight, 402
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol and ether

Properties: yellowish powder, extremely deliquescent. Must be kept in well-stoppered bottles.

Derivation: by boiling aluminum cyanide with sulfur; purified by crystallization

Grade: chemically pure

Uses in photography: Aluminum sulfocyanide is used as a preliminary bath for self-toning papers. It has been recommended in connection with gold toning baths but is unsatisfactory.

AMMONIA WATER, NH_4OH

French, ammoniaque; German, Ammoniakwasser

Synonyms: ammonium hydrate; ammonium hydroxide

Atomic weight, ------ Molecular weight, ------
Boiling point, 38.5 °C Specific gravity, 0.897 (28 percent)
Melting point, ------

Solubility: soluble in water

Properties: colorless liquid with extremely irritating fumes. Should be kept in a cold place in well-stoppered bottles

Derivation: Gas liquor from coke and gas manufacture is distilled, the volatile salts and ammonia being absorbed in sulfuric acid. This yields ammonium sulfate, which is heated to distill off the ammonia. The ammonia is collected in water. Ammonia water also made from waste animal matter.

Grade: USP (28 percent)

Uses in photography: Ammonia water is used as an accelerator in pyro developer, for blackening the mercury-bleached image in intensification, and in the bichromate bath for sensitizing carbon tissue. Ammonia is used in the ammonia nitrate process to produce exceedingly rapid emulsions. In process work it is added to the bichromated albumen and fish glue solutions.

AMMONIUM BICHROMATE, $(NH_4)_2Cr_2O$

French, bichromate d'ammoniaque; German, Ammoniumdichromat

Synonyms: ------

Atomic weight, ------ Molecular weight, 252
Boiling point, ------ Specific gravity, 2.153
Melting point, ------

Solubility: soluble in water and alcohol

Properties: yellow needles; explodes when in contact with human substance

Derivation: by chromic acid acting on ammonium hydroxide followed by crystallization

Grade: chemically pure

Uses in photography: Ammonium bichromate is sometimes used for sensitizing carbon tissue, in gum bichromate, and in various photomechanical processes. It has greater sensitizing power than the potassium salt and in the carbon processes gives stronger pictures. In process work it is used as a sensitizer for fish glue for printing halftone images on copper and zinc. Ammonium bichromate is about twice as sensitive to light as is potassium bichromate.

AMMONIUM BROMIDE, NH_4Br

French, bromure d'ammonium; German, Bromammonium

Synonyms: ------

Atomic weight, ------ Molecular weight, 98
Boiling point, ------ Specific gravity, 2.327
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: colorless crystals

Derivation: by hydrobromic acid acting on ammonium hydroxide, followed by crystallization

Grade: USP (granular)

Uses in photography: Ammonium bromide can be used as a restrainer in place of potassium salt but must not be used with the caustic alkalies or carbonates because ammonia would be set free. Largely used in emulsion-making, it produces an emulsion with slightly higher contrast than one made with potassium salt.

AMMONIUM CARBONATE, $(NH_4)HCO_2(NH_4)(NH_3)CO_2$

French, carbonate d'ammoniaque; German, Ammoniumkarbonat

Synonyms: hartshorn; rock ammonia

Atomic weight, ------ Molecular weight, 157
Boiling point, ------ Specific gravity, ------
Melting point, 85 °C

Solubility: soluble in water; decomposes in hot water

Properties: colorless crystal plates; unstable in air, rapidly converting to the bicarbonate

Derivation: by heating ammonium hydroxide with ammonium bicarbonate

Grade: USP (cubes or powder)

Uses in photography: Ammonium carbonate can be used to replace ammonia water in some developing solutions but must not be dissolved in hot water. It is frequently used to replace ammonia in the ammonia processes of emulsion-making.

AMMONIUM CHLORIDE, NH_4Cl

French, chlorure d'ammoniaque; German, Chlorammonium

Synonyms: sal ammoniac

Atomic weight, ------ Molecular weight, 53.5
Boiling point, ------ Specific gravity, 1.520
Melting point, ------

Solubility: soluble in water, alcohol, and ammonium hydroxide

Properties: white crystals

Derivation: ammonia salts acting on hydrochloric acid followed by crystallization

Grade: USP (granular)

Uses in photography: Ammonium chloride is used in salting albumenized paper. Its principal use, however, is in preparing chloride emulsions.

AMMONIUM CITRATE, $C_6H_{14}N_2O_7$

French, citrate d'ammoniaque; German, Ammoniumcitrate

Synonyms: ------

Atomic weight, ------ Molecular weight, 226.19
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: ------

Derivation: ------

Grade: ------

Uses in photography: Ammonium citrate is seldom used in photography but is occasionally used as a restrainer with pyro developer.

AMMONIUM FLUORIDE, NH_4F

French, flurure d'ammonium; German, Fluorammon

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: ------

Derivation: ------

Grade: ------

Uses in photography: Ammonium fluoride is seldom used in photography but is occasionally used for stripping negatives. It must be kept in wax-lined bottles.

AMMONIUM HYPOSULFITE, $H_8N_2O_3S$

French, hyposulfited'ammoniaque; German, Ammonthiosulfat

Synonyms: ammonium thiosulfate

Atomic weight, ------ Molecular weight, 116.4
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: ------

Derivation: ------

Grade: ------

Uses in photography: Ammonuim hyposulfite is seldom used in photography. In the earlier days it was recommended as a substitute for sodium salt.

AMMONIUM IODIDE, NH_4I

French, ------; German, ------

Synonyms: ------

Atomic weight, ------ Molecular weight, 145
Boiling point, ------ Specific gravity, 2.501
Melting point, ------

Solubility: soluble in water and alcohol

Properties: white crystals

Derivation: by ammonium hydroxide acting on hydroiodic acid, followed by crystallization

Grade: USP (granular)

Uses in photography: Ammonium iodide is used in making iodized collodion and has been recommended for negative emulsions. It is unsatisfactory for fast gelatinobromide emulsions because it is unstable and readily gives off iodine.

AMMONIUM MOLYBDATE, $H_{24}Mo_7N_6O_{24}$

French, molybdate d'ammoniaque; German, Molybdansaures ammonium

Synonyms: ------

Atomic weight, ------ Molecular weight, 1163.89
Boiling point, ------ Specific gravity, 2.38 to 2.95
Melting point, ------

Solubility: soluble in water and acids

Properties: white, crystalline powder readily decomposed by heat

Derivation: by the reaction of a solution of molybdic acid and ammonium hydroxide, followed by crystallization

Grade: USP (crystals)

Uses in photography: Ammonium molybdate is used as an ingredient in printing-out-paper emulsions to give greater contrast. It has also been recommended for increasing contrast and blacks in chloride and bromide emulsions.

AMMONIUM NITRATE, NH_4NO_3

French, azotate d'ammonium; German, Salpetersäures ammon

Synonyms: ------

Atomic weight, ------ Molecular weight, 80
Boiling point, ------ Specific gravity, 1.725
Melting point, 153 °C
(decomposes at 210 °C)

Solubility: soluble in water, alcohol, and alkalies

Properties: colorless crystals; explosive

Derivation: by ammonium hydroxide acting on nitric acid

Grade: USP (granular)

Uses in photography: Ammonium nitrate is sometimes substituted for the potassium salt in flashlight mixtures. It is one of the salts formed in emulsion-making by the double decomposition of ammonium bromide and silver nitrate.

AMMONIUM OXALATE, $(NH_4)_2C_2O_4H_2O$

French, oxalate d'ammoniaque; German, Ammonoxalat

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: ------

Properties: ------

Derivation: ------

Grade: ------

Uses in photography: Ammonium oxalate is seldom used in photography but finds occasional use in the preparation of ferric ammonio-oxalate.

AMMONIUM PERSULFATE, $(NH_4)_2S_2O$

French, persulfate d'ammoniaque; German, Ueberschwefelsaures ammonium

Synonyms: ------

Atomic weight, ------ Molecular weight, 228
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water

Properties: white crystals

Derivation: by electrolysis of a concentrated solution of ammonium sulfate, followed by crystallization

Grade: chemically pure crystals

Uses in photography: Ammonium persulfate is principally used as a reducer, its valuable property being that it reduces the highlight detail more than the shadows. It has been suggested as a hypo eliminator and is sometimes used to remove developer stains and as an addition to the oxalate developer for platinotypes. Such an addition improves the quality of overexposed platinotype prints.

AMMONIUM PHOSPHATE, $(NH_4)_2HPO_4$

French, phosphate d'ammonium; German, Ammonphosphat

Synonyms: ammonium diphosphate; diammonium orthophosphate

Atomic weight, ------ Molecular weight, 132
Boiling point, ------ Specific gravity, 1.619
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: white crystals

Derivation: by ammonium hydroxide reacting with phosphoric acid, followed by crystallization

Grade: chemically pure, granular

Uses in photography: Ammonium phosphate is frequently used for fire-proofing fabrics for use around the studio and work rooms and in making slow silver phosphate emulsions.

AMMONIUM SULFOCYANIDE, NH_4CNS

French, sulfocyanure d'ammonium; German, Rhodanammonium

Synonyms: ammonium sulfocyanate; thiocyanate; rhodanide of ammonia

Atomic weight, ------ Molecular weight, 76
Boiling point, ------ Specific gravity, 1.3057
Melting point, 159 °C

Solubility: soluble in water and alcohol

Properties: colorless, deliquescent crystals. Must be kept in well-stoppered bottles.

Derivation: by boiling an aqueous solution of ammonium cyanide with sulfur or polysulfides

Grade: pure

Uses in photography: Ammonium sulfocyanide is principally used in the gold toning bath for printing-out papers. A 5 percent solution will dissolve gelatine in the cold and has therefore found some use in the development of overexposed carbon prints.

AMMONIUM SULPHYDRATE, NH_4HS

French, sulphydrate d'ammoniaque; German, Schwefelammon

Synonyms: ammonium hydrosulfide; ammonium sulfide

Atomic weight, ------ Molecular weight, 51
Boiling point, ------ Specific gravity, ------
Melting point, decomposes

Solubility: soluble in water and alcohol

Properties: colorless, crystalline mass, rapidly turning yellow on exposure to air

Derivation: by passing sulfuretted hydrogen into liquor ammonia

Grade: pure

Uses in photography: Ammonium sulphydrate is used for blackening wet collodion negatives after intensification with lead nitrate, copper bromide, or silver iodide.

AMMONIUM THIOMOLYBDATE, $(NH_4)_2MoS_4$

French, sulfomolybdate d'ammonium; German, Thiomolybdanat ammoniak

Synonyms: ------

Atomic weight, ------ Molecular weight, 260
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: red scales

Derivation: by boiling molybdenum trisulfide in ammonium sulfide

Grade: pure

Uses in photography: ammonium thiomolybdate is used in place of sodium sulfide in sulfiding bromide prints

AMMONIUM VANADATE, NH_4VO_3

French, vanadate d'ammoniaque; German, Vanadinsäures ammoniak

Synonyms: ammonium metavanadate

Atomic weight, ------ Molecular weight, 116
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: slightly soluble in water

Properties: colorless crystals

Derivation: ------

Grade: pure

Uses in photography: Ammonium vanadate is added to printing-out emulsions to increase contrast.

AMYL ACETATE, $C_5H_{11}C_2H_3O_2$

French, acetate d'amyle; German, Amylacetat and Birnenöl

Synonyms: essence of jargonelle pears; amylacetic ester; isoamy lacetate

Atomic weight, ------ Molecular weight, 130
Boiling point, 148 °C Specific gravity, 0.8659
Melting point, ------

Solubility: very slightly soluble in water; insoluble in alcohol

Properties: colorless liquid with banana-like odor

Derivation: by adding sulfuric acid to a mixture of amyl alcohol and acetic acid, with subsequent recovery by distillation

Grade: USP

Uses in photography: Amyl acetate is one of the solvents used in the making celluloid for photographic film. When used to dissolve scrap celluloid, it yields a hard varnish that can be applied cold to negatives. It has also been used in the Hefner-Alteneck lamp, which was adopted by the International Congress of Photography in 1889 as a standard light in sensitometry.

ANTIMONY SULFIDE, Sb_2S_2

French, sulfure d'antimoine; German, Schwefelantimon

Synonyms: antimonous sulfide; black antimony

Atomic weight, ------ Molecular weight, 336
Boiling point, ------ Specific gravity, 4.562
Melting point, 546 °C

Solubility: soluble in ammonium sulfide, potassium sulfide, and hydrochloric acid; insoluble in water

Properties: black or orange-red crystals; poisonous

Derivation: occurs in nature as the black crystalline stibnite. As precipitated from solutions of antimony salts, the trisulfide is an orange-red precipitate; it is then filtered, dried, and ground.

Grade: technical

Uses in photography: Antimony sulfide is occasionally used in conjunction with magnesium powder for flashlight work, but as the products of combustion are poisonous, it is not recommended.

BARIUM BROMIDE, $BaBr_2 2H_2O$

French, bromure de baryum; German, Baryumbromid

Synonyms: ------

Atomic weight, ------ Molecular weight, 333
Boiling point, ------ Specific gravity, 3.852
Melting point, ------

Solubility: soluble in water

Properties: colorless crystals; poisonous

Derivation: by barium sulfide interacting with hydrobromic acid, followed by crystallization

Grade: technical

Uses in photography: Barium bromide is sometimes used in preparing collodion emulsions and has been recommended as a means of increasing contrast in silver bromide emulsions.

BARIUM CHLORIDE, $BaCl_2 2H_2O$

French, chlorure de baryum; German, Baryumchlorid

Synonyms: ------

Atomic weight, ------ Molecular weight, 244
Boiling point, ------ Specific gravity, 3.097
Melting point, 860 °C

Solubility: soluble in water; insoluble in alcohol

Properties: colorless flat crystals; poisonous

Derivation: by the action of hydrochloric acid on barium sulfide, with subsequent crystallization

Grade: USP

Uses in photography: Barium chloride is occasionally used in making emulsions, both collodion and silver bromide. Its principal use, however, is in preparing barium sulfate by reaction with sodium sulfate.

BARIUM IODIDE, $BaI_2 2H_2O$

French, iodure de barum; German, Iodbarum

Synonyms: ------

Atomic weight, ------ Molecular weight, 427
Boiling point, ------ Specific gravity, 5.150
Melting point, loses $2H_2O$ at 539 °C and melts at 740 °C

Solubility: soluble in water and alcohol

Properties: colorless crystals; decomposing and reddening on exposure to air; poisonous

Derivation: by hydriodic acid acting on barium hydroxide

Grade: technical

Uses in photography: Barium iodide is frequently used in making collodion emulsions because it increases contrast.

BARIUM SULFATE, $BaSO_4$

French, sulfate de baryum; German, Schwefelsäures baryt; Schwerspat

Synonyms: barytes; synthetic barytes; blanc fixe; permanent white baryta; mountain snow

Atomic weight, ------ Molecular weight, 233
Boiling point, ------ Specific gravity, 4.476
Melting point, ------

Solubility: soluble in concentrated sulfuric acid; insoluble in water

Properties: heavy, white, impalpable powder; poisonous

Derivation: by sulfuric acid or sodium sulfate acting on solutions of barium salts, followed by careful drying and grinding

Grade: technical photographic

Uses in photography: Barium sulfate is principally used in coating photographic paper to produce a smooth, white, inert surface upon which to coat the sensitive emulsions. The barium sulfate coating also insulates the paper stock and prevents any reaction between the organic material of the paper and the emulsion that might result in decomposition and fog. According to the surface required, various crystalline forms of barium sulfate are used, the two most common being glossy and matte blanc fixe. Barium sulfate is also added to emulsions to produce a semimatte surface.

BENZOL (BENZENE), C_4H_4

French, benzol and benzine crystallizable; German, Benzol and Steinkohlenbenzin

Synonyms: benzol or benzole; coal tar naphtha; phenyl hydride

Atomic weight, ------ Molecular weight, 78
Boiling point, 79.7 °C Specific gravity, 0.87843
Melting point, 5.483 °C

Solubility: soluble in alcohol and ether; insoluble in water

Properties: clear, colorless, inflammable liquid with a characteristic odor; solidifies at 0 °C

Derivation: (a) Illuminating gas and coke-oven gas are "scrubbed" by passing them through oil, which thus becomes saturated with benzol and toluol. The resulting oil is distilled. Benzol and toluol are recovered and then separated by fractional distillation. (b) Coal tar is dehydrated and then fractionally distilled, yielding "light oil." The first distillation runs contain the crude benzol.

Grade: USP

Uses in photography: Benzol is used in preparing a number of photographic varnishes, particularly matte varnish. In process work benzol is largely used for dissolving India rubber to make the edging solution for wet collodion negatives and for coating wet plates before applying collodion for stripping. It is an excellent solvent for asphaltum and is also used as a solvent in preparing encaustic paste. Benzol must not be confused with benzine, which is practically identical with gasoline.

CADMIUM-AMMONIUM BROMIDE, $2CdBr_2 2NH_4Br H_2O$

French, bromure double de cadmium et d'ammonium; German, zweifach-ammonium-Cadmiumbromid

Synonyms: ------

Atomic weight, ------ Molecular weight, 758
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and alcohol and in equal parts of alcohol and ether

Properties: ------

Derivation: by dissolving crystallized cadmium bromide and ammonium bromide in water and then crystallizing

Grade: ------

Uses in photography: This double salt has found considerable use in collodion processes because of its stability. It considerably increases the sensitiveness of the collodion emulsion.

CADMIUM-AMMONIUM IODIDE, CdI

French, iodure double de cadmium et d'ammonium; German, zweifach-ammonium-Cadmiumiodid

Synonyms: ------

Atomic weight, ------ Molecular weight, 692
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and alcohol and in mixtures of alcohol and ether

Properties: ------

Derivation: by dissolving ammonium iodide and cadmium iodide in water and then crystallizing

Grade: ------

Uses in photography: Cadmium-ammonium iodide is used in collodion emulsions, giving considerably more sensitiveness than the single salts.

CADMIUM BROMIDE, $CdBr_34H_2O$

French, bromure de cadmium; German, Bromcadmium

Synonyms: ------

Atomic weight, ------ Molecular weight, 344
Boiling point, 806 to 812 °C Specific gravity, 5.192
Melting point, 568 °C

Solubility: soluble in water and alcohol; slightly soluble in ether

Properties: yellowish, crystalline powder

Derivation: by heating cadmium to redness in bromine vapor

Grade: technical photographic

Uses in photography: Cadmium bromide is used in collodion emulsions.

CADMIUM CHLORIDE, $CdCl_22H_2O$

French, chlorure de cadmium; German, Chloracadmium

Synonyms: ------

Atomic weight, ------ Molecular weight, 201
Boiling point, 861 to 954 °C Specific gravity, 3.327
Melting point, 568 °C

Solubility: soluble in water and alcohol

Properties: small, white crystals

Derivation: by hydrochloric acid acting on cadmium, with subsequent crystallization

Grade: technical photographic

Uses in photography: Cadmium chloride is sometimes used in collodion emulsions.

CADMIUM IODIDE, CdI_2

French, iodure de cadmium; German, Iodcadmium

Synonyms: ------

Atomic weight, ------ Molecular weight, 366
Boiling point, 708 to 719 °C Specific gravity, 5.644
Melting point, 385 °C

Solubility: soluble in water, alcohol, and ether

Properties: colorless, flaky crystals

Derivation: by hydriodic acid acting on cadmium oxide, and subsequent crystallization

Grade: technical photographic

Uses in photography: Cadmium iodide is the best salt for iodizing collodion for process negatives. It is used in conjunction with ammonium iodide.

CALCIUM BROMIDE, $CaBr_2$

French, bromure de calcium; German, Bromcalcium

Synonyms: ------

Atomic weight, ------ Molecular weight, 200
Boiling point, 806 to 812 °C Specific gravity, 3.353
Melting point, 680 to 760 °C

Solubility: soluble in water

Properties: white, granular, very deliquescent crystals with sharp, saline taste. Should be kept in well-stoppered bottles.

Derivation: by hydrobromic acid acting on calcium oxide, carbonate, or hydroxide and subsequent crystallization.

Grade: USP

Uses in photography: Calcium bromide is used in making collodion emulsions.

CALCIUM CARBONATE (CHALK), $CaCO_3$

French, carbonate de chaux; German, Kreide and Kohlensäures kalk

Synonyms: -----

Atomic weight, ------ Molecular weight, 100
Boiling point, ------ Specific gravity, 2.72 to 2.95
Melting point, ------

Solubility: soluble in acids; insoluble in water

Properties: white, amorphous powder or colorless crystals

Derivation: by adding a soluble carbonate to a calcium salt solution

Grade: USP

Uses in photography: Calcium carbonate is used in neutralizing gold toning baths.

CALCIUM CHLORIDE (CRYSTALS), $CaCl_26H_2O$

French, chlorure de calcium; German, Chlorcalcium

Synonyms: ------

Atomic weight, ------ Molecular weight, 219
Boiling point, ------ Specific gravity, 1.654
Melting point, ------

Solubility: soluble in water and alcohol

Properties: white, deliquescent crystals. Must be kept in well-stoppered bottles.

Derivation: commercially obtained as a byproduct in the Solvay soda process and in the manufacture of potassium chlorate

Grade: USP

Uses in photography: Calcium chloride is used occasionally in making emulsions. The commercial dry chloride ($CaCl_22H_2O$) is used as a desiccating agent for platinotype and other papers. In process work it is a constituent of the iodizer for collodion. Small circles of filter or blotting paper saturated with a solution of calcium chloride are placed in the tin cans in which film is packed for the tropics.

CAMPHOR, CHO

French, camphre; German, Kampfer

Synonyms: Formosa camphor; Japan camphor

Atomic weight, ------ Molecular weight, 152
Boiling point, 204 °C Specific gravity, 0.986 to 0.996
Melting point, 175 °C

Solubility: soluble in alcohol, ether, chloroform, and carbon bisulfide

Properties: white, translucent masses; easily broken

Derivation: from the wood of the camphor laurel tree

Grade: technical; USP

Uses in photography: Camphor is used in manufacturing a number of photographic varnishes and retouching mediums. It is one of the most important constituents of celluloid, having a marked influence on the physical properties of the

finished material. In celluloid manufacture camphor functions as a latent solvent and influences the life of the sheet and its flexibility. A number of substitutes for camphor have been suggested, but none of them are quite as satisfactory as the genuine material.

CARBON DISULFIDE, CS_2

French, sulfure de carbone; German, Schwefelkonhlenstoff

Synonyms: carbon bisulfide

Atomic weight, ------ Molecular weight, 76
Boiling point, 46.25 °C Specific gravity, 1.2927
Melting point, -111.6 °C

Solubility: soluble in alcohol and ether; slightly soluble in water

Properties: clear, colorless, flammable liquid; poisonous. Care must be used in handling it because the vapor, when mixed with air, forms an explosive compound.

Derivation: by sulfur vapors acting on red-hot carbon, the vapors formed being condensed; or by heating sulfur and carbon in an electric furnace and condensing the carbon bisulfide vapors

Grade: technical

Uses in photography: Carbon disulfide is used in preparing various cold varnishes, as it is a good solvent of amber and other resins. It is also used as a solvent for India rubber in making rubber solutions.

CARBON TETRACHLORIDE, CCl_4

French, ------; German, ------

Synonyms: tetrachloromethane

Atomic weight, ------ Molecular weight, 156
Boiling point, 76.74 °C Specific gravity, 1.5835
Melting point, -22.95 °C

Solubility: soluble in alcohol and ether; slightly soluble in water

Properties: light, colorless liquid with a peculiar odor; yields heavy vapors; nonflammable; poisonous

Derivation: by carbon bisulfide and chlorine interacting in the presence of a catalyzer

Grade: technical

Uses in photography: Carbon tetrachloride is an excellent solvent of shellac, asphalt, and fats. It is valuable as a cleaning fluid, as it has no action on metals, colors, or fabrics.

CELLULOID

French, celluloide; German, Celluloid

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in alcohol and ether and in various mixtures of amylacetate, acetone, fusel oil, etc.; insoluble in water

Properties: Highly flammable

Derivation: by mixing nitrated cellulose, camphor, and other ingredients in suitable solvents, producing what is known as "dope." This is a viscous solution that is flowed upon a casting wheel; upon the evaporation of the solvents, sheet celluloid is obtained. It is produced in long rolls of suitable width and in varying thicknesses, according to the purpose for which it is intended.

Grade: ------

Uses in photography: Sheet celluloid is the most important flexible emulsion support used in the production of modern roll and motion picture film. The so-called noncurling roll film is produced by applying a suitable coating of celluloid on the side opposite to that on which the emulsion is coated to counteract the natural curl. For motion picture film, sheet celluloid is now produced in a number of different colors to largely do away with tinting and toning.

CELLULOSE ACETATE, $C_6H_5(CO_2CH_3)_5$

French, cellulose acetate; German, Celluloseacetat

Synonyms: sericose

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in alcohol; insoluble in water

Properties: yellowish, transparent amorphous mass; nonflammable

Derivation: by the acetylizing cellulose in the presence of sulfuric acid

Grade: special photographic

Uses in photography: Cellulose acetate is the basis of the modern nonflammable photographic and motion picture film. A number of forms of this material are known, their properties varying according to the process of manufacture. Some forms are insoluble in alcohol; some are soluble in chloroform, etc.

CERIC SULFATE, $Ce(SO_4)_24H_2O$

French, sulfate de cerium and sulfate cerique; German, Cerisulfat

Synonyms: sulfate of cerium

Atomic weight, ------ Molecular weight, 404
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water

Properties: reddish-yellow crystals

Derivation: by sulfuric acid acting on cerium carbonate

Grade: technical

Uses in photography: Ceric sulfate is used as a photographic reducer, a 5 percent solution acting more strongly on the highlights of a negative than on the shadows. It is also used for sensitizing paper in the cerium printing processes and produces prints in a great variety of colors according to the organic substances with which the prints are treated.

CHLORAL HYDRATE, $CCl_3CH(OH)_2$

French, chloral hydrate; German, chloral Hydrat

Synonyms: trichloradelhyde

Atomic weight, ------ Molecular weight, 165.5
Boiling point, 97.5 °C Specific gravity, 1.901
Melting point, 57 °C

Solubility: soluble in water, alcohol, and ether

Properties: transparent, colorless crystals; poisonous

Derivation: by the action of one-fifth of its volume of water on chloral

Grade: USP

Uses in photography: Chloral hydrate is sometimes used as a solvent of gelatine in manufacturing photographic mountants and has been used in preparing nonflammable film.

CHLOROFORM, $CHCl_3$

French, chloroforme; German, Chloroform

Synonyms: trichloromethane; methyl trichloride

Atomic weight, ------ Molecular weight, 119.5
Boiling point, 61.20 °C Specific gravity, 1.49887
Melting point, -63.2 °C

Solubility: soluble in alcohol and ether; slightly soluble in water

Properties: clear, colorless, highly refractive, volatile liquid with a characteristic odor; nonflammable

Derivation: by calcium oxychloride reacting with acetone, and with subsequent distillation

Grade: USP

Uses in photography: Chloroform is a solvent of amber and resins and is useful in preparing a number of varnishes. It is also a good solvent for iodine, bromine, camphor, and some forms of cellulose acetate. It should be kept in the dark.

COBALT CHLORIDE, $CoCl_2 6H_2O$

French, chlorure de cobalt; German, Kobaltchlorid

Synonyms: cobaltous chloride

Atomic weight, ------ Molecular weight, 238
Boiling point, ------ Specific gravity, 1.84
Melting point, 86.75 °C

Solubility: soluble in water and alcohol

Properties: ruby-red crystals

Derivation: by hydrochloric acid acting on cobalt oxide, with subsequent crystallization

Grade: technical

Uses in photography: Adding a small amount of cobalt chloride to printing-out emulsions increases contrast. It is one of the constituents of the cobalt-lead toning bath, where it gives a green image on bromide and gaslight papers.

COPPER BROMIDE, CuBr

French, bromure de cuivre; German, Kupferbromid

Synonyms: cupric bromide

Atomic weight, ------ Molecular weight, 223.5
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; slightly soluble in alcohol

Properties: greyish-black crystalline powder

Derivation: most easily prepared by double decomposition of solutions of copper sulfate and potassium bromide

Grade: chemically pure

Uses in photography: Copper bromide has been used for intensifying negatives and for bleaching bromide prints prior to sulfide toning. In process work the copper bromide intensifier is used for halftone negatives; it has a marked cutting action that tends to sharpen up the dots. Still greater density can be obtained by flowing it over a solution of either sodium or ammonium sulfide.

COPPER CHLORIDE, $CuCl2H_2O$

French, chlorure de cuivre; German, Kupferchlorid

Synonyms: cupric chloride; copper bi- or dichloride

Atomic weight, ------ Molecular weight, 170.5
Boiling point, ------ Specific gravity, 2.47
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: greenish-blue, deliquescent crystals; poisonous. Must be kept in well-stoppered bottles.

Derivation: Copper carbonate is dissociated with hydrochloric acid and the product is crystallized.

Grade: pure crystals

Uses in photography: Copper chloride is occasionally used as a reducer according to Spiller's formula. Added to printing-out emulsions it increases contrast. It is also used in Obernetter's photogravure process. A small amount of a 1 percent solution of copper chloride added to silver bromide emulsion reduces the speed and enhances contrast.

COPPER SULFATE, $CuSO_45H_2O$

French, sulfate de cuivre; German, Kupfersulfat

Synonyms: cupric sulfate; blue vitriol

Atomic weight, ------ Molecular weight, 249.5
Boiling point, ------ Specific gravity, 2.284
Melting point, ------

Solubility: soluble in water and alcohol

Properties: blue crystals, slowly efflorescing in air; almost white when dehydrated; poisonous. Should be kept in well-stoppered bottles.

Derivation: by sulfuric acid acting on copper or copper oxide in large quantities, with later evaporation and crystallization

Grade: USP

Uses in photography: With an excess of liquor ammonia copper sulfate gives a blue solution that forms a useful filter for color sensitometry and three-color work. It is one of the constituents of the bromoiodide-of-copper intensifying solution and is used in copper toning baths to produce various tones from warm black to red chalk upon bromide prints. In process work copper sulfate is added to the wet-plate developer to retard the oxidation of the ferrous sulfate. In electrotyping it is used with sulfuric acid to form the depositing solution.

ETHER, CHOCH

French, ether sulfurique; German, Aether

Synonyms: ethyl oxide; ethylic ether; sulfuric ether

Atomic weight, ------ Molecular weight, 74
Boiling point, 34.97 °C Specific gravity, 0.71994
Melting point, -116.2 °C

Solubility: soluble in water and alcohol

Properties: very light, transparent, colorless, volatile, exceedingly flammable, mobile liquid with pleasant aromatic odor. Have no flames or sparking electrical equipment present when ether is being used. Should be kept in well-stoppered bottles in a cool place.

Derivation: by sulfuric acid acting on ethyl alcohol, followed by distillation

Grade: USP

Uses in photography: Ether is used in preparing collodion and varnishes, for washing bitumen to increase its sensitiveness, and with alcohol as a solvent for bitumen in a process for graining the plate by reticulation. Ether is a solvent for certain forms of cellulose acetate as well as for iodine, bromine, sulfur, phosphorus, many essential oils, corrosive sublimate, and other salts.

FERRIC AMMONIO-CITRATE (BROWN), $4FeC_6H_5O_73(NH_4)_2C_4H_5O_73Fe(OH)_2$

French, citrate de fer ammoniacale; German, braune Citronensäure eisenoxydammoniak

Synonyms: ammonium citrate of iron

Atomic weight, ------ Molecular weight, 2030
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: reddish-brown, transparent, hygroscopic crystalline scales; saline taste; deliquescent in moist air. Should be kept in well-stoppered bottles and in the dark.

Derivation: by adding citric acid and then ammonium hydroxide to ferric hydroxide, followed by filtration

Grade: USP

Uses in photography: Ferric ammonium-citrate is used in conjunction with potassium ferricyanide in the iron printing processes. There is also a green salt, which gives more sensitive papers with cleaner whites than the brown salt.

FERRIC AMMONIO-OXALATE, $Fe_2(C_2O_4)_33(NH_4)_2C_2O_48H_2O$

French, oxalate ammoniaco-ferrique; German, Ammonium ferrioxalat

Synonyms: ammonium oxalate of iron; oxalate of iron and ammonia

Atomic weight, ------ Molecular weight, 892
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water

Properties: green crystals

Derivation: by ammonium binoxalate interacting with ferric hydroxide

Grade: technical

Uses in photography: Ferric ammonio-oxalate is sometimes used in preparing blueprints. It is also used in the cold development of platinum and platinum printing processes.

FERRIC AMMONIO-SULFATE, $FeSO_4(NH_4)_2SO_46H_2O$

French, sulfate de fer ammoniacale; German, Schwefelsäure and Eisenoxydammoniak

Synonyms: ammonium sulfate of iron

Atomic weight, ------ Molecular weight, 328
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: pale-green crystals

Derivation: by mixing solutions of ferric sulfate and ammonium sulfate, followed by evaporation and crystallization

Grade: chemically pure

Uses in photography: Ferric ammonio-sulfate is occasionally used as a substitute for ferrous sulfate because of its greater stability and has been used in developing wet plates.

FERRIC CHLORIDE (LUMP), $FeCl_36H_2O$

French, chlorure ferrique; German, Eisenchlorid

Synonyms: perchloride or sesquichloride of iron; iron trichloride

Atomic weight, ------ Molecular weight, 270.5
Boiling point, ------ Specific gravity, ------
Melting point, 37 °C

Solubility: soluble in water, alcohol, and ether

Properties: very deliquescent, orange-yellow crystals (lumps)

Derivation: by passing chlorine into a solution of ferrous chloride

Grade: USP

Uses in photography: Ferric chloride is sometimes used as a reducer for negatives but is not to be recommended as it is likely to produce yellow stains by formation of basic ferrous salts. In process work it is used as a mordant in photogravure and halftone plates.

FERRIC OXALATE, $Fe_3(C_2O_4)_3$

French, oxalate ferrique; German, Ferrioxalat

Synonyms: iron sesquioxalate

Atomic weight, ------ Molecular weight, 376
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: greenish glistening scales; extremely sensitive to light

Derivation: A solution of ammonia-iron-alum and liquor ammonia is mixed together and allowed to stand until the precipitated ferric hydrate has settled. Pure oxalic acid is then added, and the mixture is allowed to stand in the dark until the precipitate is completely dissolved.

Grade: technical

Uses in photography: Ferric oxalate is used in the Kallitype process. Its chief use, however, is as the sensitive salt in the platinotype process.

FERRIC SODIUM OXALATE, $Fe(C_2O_4)_3 3Na_2C_2O_4 11H_2O$

French, oxalate de fer et de soude; German, Natriumferrioxalat

Synonyms: sodio-ferric oxalate

Atomic weight, ------ Molecular weight, 976
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: emerald-green crystals

Derivation: by sodium acid oxalate interacting with ferric hydroxide

Grade: technical photographic

Uses in photography: Ferric sodium oxalate is used in preparing platinum printing paper.

FERRIC SULFATE, $Fe_2(SO_4)_3 9H_2O$

French, sulfate ferrique; German, Ferrisulfat, Schwefelsäure, and Eisenoxyd

Synonyms: sesquisulfate of iron

Atomic weight, ------ Molecular weight, 563
Boiling point, ------ Specific gravity, 2 to 2.1
Melting point, decomposes

Solubility: soluble in water

Properties: greenish crystals

Derivation: by adding sulfuric acid to a solution of ferrous sulfate

Grade: USP

Uses in photography: Ferric sulfate has been suggested as a reducer but is very likely to give yellow stains by forming basic iron salts in the film.

FERROUS NITRATE, $Fe(NO_3)_2 18H_2O$

French, azotate ferreux; German, Salpetersäure eisenoxydul

Synonyms: protonitrate of iron

Atomic weight, ------ Molecular weight, 536
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and in dilute alcohol

Properties: greenish-white crystals

Derivation: by mixing ferrous sulfate with barium nitrate in solution

Grade: ------

Uses in photography: Ferrous nitrate is used in the wet collodion process. It gives a much whiter image than ferrous sulfate.

FERROUS POTASSIUM OXALATE, $K_2Fe(C_2O_4)_2H_2O$

French, oxalate de potassium ferreux; German, Kalium-eisenoxalat

Synonyms: potassio-ferrous oxalate

Atomic weight, ------ Molecular weight, 328
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water

Properties: ------

Derivation: occurs in the ferrous oxalate developer by the mixture of ferrous sulfate and potassium oxalate

Grade: ------

Uses in photography: The ferrous oxalate developer is one of the oldest for plates and bromide papers and has almost entirely been replaced by the modern organic developers. Its advantage is the production of an image in pure metallic silver, that is to say, without stain. When used for bromide papers, an acid bath after development is necessary to prevent the deposition of basic iron salts in the paper. Bromide acts as a restrainer, and small quantities of hypo solution act as an accelerator with this developer. Ferrous potassium oxalate can also be used as the blackening solution when intensifying with mercuric chloride. It allows repeated bleaching and blackening.

FERROUS SULFATE, $FeSO_47H_2O$

French, sulfate de fer; German, Schwefelsäures eisenoxydul

Synonyms: sulfate or protosulfate of iron; green copperas; green vitriol

Atomic weight, ------ Molecular weight, 278
Boiling point, ------ Specific gravity, 1.8987
Melting point, 64 °C

Solubility: soluble in water; insoluble in alcohol

Properties: greenish crystals, often rusty in color from oxidation and effloresence. Before use the rusty powder should be rinsed off.

Derivation: (a) A byproduct from the pickling of steel. (b) By the action of dilute sulfuric acid on iron, with subsequent crystallization.

Grade: USP

Uses in photography: Ferrous sulfate is used as a developer for wet collodion plates and is one of the ingredients used in preparing the ferrous oxalate developer.

FORMALIN, CH_2O

French, formol; German, Aldhyde formique

Synonyms: formaldehyde, formic aldehyde

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, 1.075 to 1.081
Melting point, ------

Solubility: soluble in water and alcohol

Properties: clear, colorless liquid with a suffocating odor; poisonous; an aqueous solution of formaldehyde gas. The vapors attack the mucous membrane of the eyes, nose, and throat, causing intense irritation.

Derivation: The vapors of methyl alcohol are passed through a heated copper tube and subsequently absorbed in water.

Grade: USP (40 percent)

Uses in photography: Formalin is used as a hardening bath immediately after fixing for both negatives and prints. A suitable strength is 10 percent. Used in conjunction with the hydroquinone developer it yields negatives of great contrast. In emulsion work formalin is used as a hardener. A very small amount considerably raises the melting point of gelatine. Emulsions hardened with formalin can stand warm developing solutions exceptionally well.

GELATIN

French, gelatine; German, Gallerte and Gelatin

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in hot water; insoluble in alcohol and ether; also insoluble in cold water but will absorb it and swell up to a slimy mass

Properties: translucent sheets or flakes

Derivation: by extraction with water from certain kinds of bones and parts of the skin of cattle, selected, washed, and treated with especial care so that the resulting product is cleaner and purer than ordinary glue. The raw stock for photographic gelatines must be carefully chosen, as it has a decided influence on the characteristics and behavior of the finished product.

Grade: photographic (hard, medium, soft)

Uses in photography: Gelatin is used in preparing baryta coating solutions for photographic paper and in collotype, photogravure, and many other photomechanical processes. It is the chief ingredient in photographic mountants. Solutions of sulfocyanide and barium chloride dissolve gelatine in the cold, and so do acetic, oxalic, hydrochloric, and sulfuric acids. Gelatin is the principal factor in modern emulsion-making, acting as the supporting colloid for silver iodide, bromide, or chloride. For emulsion-making it is nearly always necessary to use a proper blend or selection of hard and soft gelatines in order to secure the desired photographic quality. In process work gelatine has many uses: in preparing photolithographic paper, carbon tissue, gelatine reliefs, substratum on glass plates or films, and lithotransfer papers; in stripping negative films; and in making color filters and glazing prints.

GLYCERIN, $C_3H_5(OH)_3$

French, glycerine; German, Glyzerin

Synonyms: ------

Atomic weight, ------ Molecular weight, 92
Boiling point, 290 °C Specific Gravity, 1.2604
Melting point, 17 °C

Solubility: soluble in water and alcohol; insoluble in ether

Properties: clear, colorless, or pale yellow, odorless, syrupy liquid with sweet, warm taste

Derivation: by precipitating salt, albuminoids, and metallic soaps of the higher fatty acids from the spent lye liquor resulting from the saponification of fats and oils in the soap industry with iron persulfate (crude) or aluminum sulfate and concentrating with subsequent steam distillation

Grade: USP

Uses in photography: Glycerin is used as a control in developing platinotypes and is frequently added to emulsions to ensure a smooth coating and to prevent curling. Motion picture film is immersed in a glycerine bath to keep it flexible and supple. Glycerin is used for etching or damping collotype plates before inking.

GOLD CHLORIDE (YELLOW), $AuCl_3$

French, chlorure d'or; German, Goldchlorid

Synonyms: trichloride or perchloride of gold; auric chloride

Atomic weight, ------ Molecular weight, 303
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: yellowish-brown crystals; very hygroscopic. Should be kept in solution.

Derivation: by dissolving gold in aqua regia

Grade: photographic

Uses in photography: Gold chloride is principally used in toning baths for gelatinochloride and collodiochloride printing-out papers. In some of the so-called self-toning papers gold chloride is added to the emulsion.

HYDRAZINE, NH_2NH_2

French, hydrazine; German, Hydrazin

Synonyms: diamidogen or diamine

Atomic weight, ------ Molecular weight, 32
Boiling point, 113.5 °C Specific gravity, 1.013
Melting point, 1.4 °C

Solubility: soluble in water and alcohol

Properties: colorless liquid

Derivation: by reducing nitrosamine with zinc dust and acetic acid

Grade: special photographic

Uses in photography: Several hydrazine compounds have been used as additions to emulsions to obtain more contrast and are said to increase the latitude of an emulsion, making it difficult to overexpose.

HYDROGEN PEROXIDE, H_2O_2

French, pèroxyde d'hydrogène and eau oxygènèe; German, Wasserstoffperoxyd

Synonyms: hydrogen dioxide; hydroxyl; perhydrol

Atomic weight, ------ Molecular weight, 34
Boiling point, ------ Specific gravity, 1.111
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: colorless, heavy liquid, appearing in commerce in the form of an aqueous solution; a powerful oxidizing agent. Keep cool and dark.

Derivation: by the action of dilute mineral acid, usually sulfuric or barium peroxide

Grade: USP (30 percent by weight)

Uses in photography: Hydrogen peroxide has been suggested as a hypo eliminator. When rendered alkaline, it is a weak developer. The action of wood, resins, etc., on dry plates has been ascribed to the presence of hydrogen peroxide. Recent investigations have shown that hydrogen peroxide can produce an effect equivalent to light action on photographic emulsions.

LEAD ACETATE, $Pb(CH_3COO)_2 3H_2O$

French, acetate de plomb; German, Bleiacetat

Synonyms: sugar of lead; normal plumbic acetate

Atomic weight, ------ Molecular weight, 379
Boiling point, 280 °C Specific gravity, 2.50
Melting point, loses $3H_2O$ at 75 °C

Solubility: soluble in water; insoluble in alcohol

Properties: white crystals (commercial grades are frequently brown or gray lumps); poisonous

Derivation: by acetic acid acting on litharge

Grade: USP

Uses in photography: Lead acetate is used in some forms of combined toning and fixing baths.

LEAD CHROMATE, $PbCrO_4$

French, chromate de plomb; German, Chromsäures blei

Synonyms: ------

Atomic weight, ------ Molecular weight, 323
Boiling point, ------ Specific gravity, 6.123
Melting point, decomposes at 600 °C

Solubility: soluble in acids; insoluble in water

Properties: yellow crystals; poisonous

Derivation: by interaction of solutions of sodium chromate and lead nitrate

Grade: technical

Uses in photography: Lead chromate is used as a pigment and in preparing of orange fabric for dark room illumination. A useful orange safelight may be prepared by bathing a fixed-out plate for several minutes in a 5 percent potassium chromate solution, rinsing, and then immersing in lead acetate solution, washing, and drying.

LEAD NITRATE, $Pb(NO_3)_2$

French, azotate de plomb; German, Bleinitrat

Synonyms: ------

Atomic weight, ------
Boiling point, ------
Melting point, decomposes between 205 and 223 °C
Molecular weight, 331
Specific gravity, 4.53

Solubility: soluble in water and alcohol

Properties: white crystals; promotes combustion in contact with organic matter; poisonous

Derivation: by nitric acid acting on lead

Grade: USP

Uses in photography: Lead nitrate is used in the lead intensifier and in some combined toning and fixing baths.

LITHIUM BROMIDE, LiBr

French, bromure de lithium; German, Bromlithium

Synonyms: ------

Atomic weight, ------
Boiling point, ------
Melting point, 442 to 547 °C
Molecular weight, 87
Specific gravity, 3.466

Solubility: soluble in water, alcohol, and ether

Properties: white crystals; very deliquescent. Must be kept in well-stoppered bottles.

Derivation: by hydrobromic acid acting on lithium hydroxide, with subsequent crystallization

Grade: USP

Uses in photography: Because of its solubility in ether and alcohol, lithium bromide is used in making collodion emulsions.

LITHIUM CHLORIDE, LiCl

French, chlorure de lithium; German, Chlorlithium

Synonyms: ------

Atomic weight, ------ Molecular weight, 42.5
Boiling point, ------ Specific gravity, 1.998 to 2.074
Melting point, 602 °C

Solubility: soluble in water, alcohol, and ether

Properties: white crystals

Derivation: by hydrochloric acid acting on lithium hydroxide, with subsequent crystallization

Grade: technical granular

Uses in photography: Lithium chloride is used in collodio-chloride printing-out emulsions. It has been recommended to increase contrast in gelatino-chloride emulsions.

MAGNESIUM BROMIDE, $MgBr_2 6H_2O$

French, bromure de magnesium; German, Brommagnesium

Synonyms: ------

Atomic weight, ------ Molecular weight, 291
Boiling point, ------ Specific gravity, ------
Melting point, decomposes

Solubility: soluble in water; slightly soluble in alcohol

Properties: colorless, very deliquescent crystals; bitter taste

Derivation: by hydrobromic acid acting on magnesium oxide, with subsequent crystallization

Grade: technical granular

Uses in photography: Magnesium bromide is used in making collodion emulsions and has been recommended to increase contrast in gelatinobromide emulsions.

MAGNESIUM CARBONATE, $MgCO_3$

French, carbonate de magnesium; German, Kohlensäures magnesium

Synonyms: ------

Atomic weight, ------ Molecular weight, 84
Boiling point, ------ Specific gravity, 3.04
Melting point, decomposes at 350 °C

Solubility: soluble in acids; insoluble in water

Properties: very light, white powder, consisting of a mixture of crystals and amorphous particles

Derivation: found as such in nature

Grade: USP

Uses in photography: In process work magnesium carbonate is used by photoengravers for rubbing into the hollows of an etched plate so that the progress of etching may be seen. In the form of a fine powder it is used in the dry enamel process.

MAGNESIUM CHLORIDE, $MgCl_2 6H_2O$

French, chlorure de magnesium; German, Chlormagnesium

Synonyms: ------

Atomic weight, ------ Molecular weight, 202
Boiling point, decomposes Specific gravity, 1.569
Melting point, loses $2H_2O$ at 100 °C

Solubility: soluble in water and alcohol;

Properties: colorless or white crystals; deliquescent. Must be kept in well-stoppered bottles.

Derivation: by hydrochloric acid acting on magnesium oxide

Grade: fused

Uses in photography: Magnesium chloride has been suggested as a fixing agent but is not as powerful as hypo. It is occasionally used in making collodion emulsions.

MERCURY CHLORIDE (MERCURIC), $HgCl_2$

French, bichlorure de mercure; German, Quecksilberchlorid

Synonyms: perchloride or bichloride of mercury; corrosive sublimate

Atomic weight, ------ Molecular weight, 271
Boiling point, 303 °C Specific gravity, 5.32
Melting point, 265 °C

Solubility: soluble in water, alcohol, ether, pyridine, and acetic acid ester

Properties: white crystals; very poisonous. Should be kept in the dark.

Derivation: by subliming common salt and mercuric sulfate

Grade: USP

Uses in photography: Mercury chloride is used as the bleaching agent in mercurial intensification. Used in small amounts in connection with the hypo alum bath it produces colder sepia tones.

MERCURY IODIDE (MERCURIC), HgI_2

French, iodure de mercure; German, Quecksilberiodid

Synonyms: red iodide of mercury; bimodide of mercury

Atomic weight, ------ Molecular weight, 454
Boiling point, 349 °C Specific gravity, 6.20 to 6.32
Melting point, 241 to 257 °C

Solubility: soluble in sodium thiosulfate or potassium iodide solutions; insoluble in water

Properties: scarlet-red, amorphous powder; poisonous

Derivation: usually by precipitation of mercuric chloride solution with potassium iodide

Grade: USP

Uses in photography: Mercury iodide is used in intensification.

MERCURY SULFOCYANIDE, $Hg(SCN)_2$

French, sulfocyanure de mercure; German, Rhodanquecksilber

Synonyms: mercuric sulfocyanate; rhodanide

Atomic weight, ------ Molecular weight, 316
Boiling point, ------ Specific gravity, ------
Melting point, decomposes

Solubility: soluble in alcohol; slightly soluble in water

Properties: white powder; poisonous; explosive

Derivation: by precipitation of mercuric nitrate with ammonium sulfocyanate, solution in a large amount of hot water, and crystallizing

Grade: technical

Uses in photography: Mercury sulfocyanide is a good intensifier for negatives, giving a good black image. Further intensification can be obtained by afterwards applying a developer.

POTASSIUM BICHROMATE, $K_2Cr_2O_7$

French, bichromate de potasse; German, Kaliumbichromate, Säures rotes, and Chromsäures kalium

Synonyms: potash or potassium dichromate; acid or red potassium chromate

Atomic weight, ------ Molecular weight, 294
Boiling point, decomposes at 500 °C Specific gravity, 2.692
Melting point, 396 °C

Solubility: soluble in water; insoluble in alcohol and ether

Properties: bright, yellowish-red, transparent crystals with a bitter, metallic taste; poisonous

Derivation: by heating an aqueous solution of sodium bichromate with potassium chloride and concentrating the solution, whereupon sodium chloride is deposited in the vessel. Lead rods are suspended in the solution and bichromate crystallizes on these.

Grade: USP

Uses in photography: Potassium bichromate is used in the carbon process and in many photomechanical processes, as it has the property of rendering gelatine, fish glue, and other colloids insoluble after they have been acted upon by light. It is also used for sensitizing photolithographic paper, collotype plates, and the albumen coating for zinc. It is used in conjunction with sulfuric acid for cleaning glass and bottles.

POTASSIUM BROMIDE, KBr

French, bromure de potasse; German, Bromkalium

Synonyms: bromide of potassium or potash

Atomic weight, ------ Molecular weight, 1119
Boiling point, 1435 °C Specific gravity, 2.749
Melting point, 730 °C

Solubility: soluble in water; slightly soluble in alcohol and ether

Properties: white crystalline granules or powder with a pungent, strong, bitter saline taste; somewhat hygroscopic

Derivation: by treating potassium hydroxide in hot solution with bromine, evaporating the solution to dryness, mixing the residue with carbon, and heating it to redness

Grade: USP

Uses in photography: Potassium bromide is principally used in manufacturing gelatinobromide emulsions. It also acts as a restrainer in development and is most active with pyro, hydroquinone, and para-amidophenol. In process work it is used in making the copper bromide intensifying solution for wet-plate negatives.

POTASSIUM CARBONATE, K_2CO_2

French, chlorate de potasse; German, Chlorsäures kalium

Synonyms: chlorate of potash

Atomic weight, ------
Boiling point, decomposes at about 400 °C, giving off oxygen
Melting point, 357 °C
Molecular weight, 122.5
Specific gravity, 2.337

Solubility: soluble in water and alkalis; slightly soluble in alcohol

Properties: transparent, colorless crystals or white powder with a cooling saline taste; poisonous. Must not be ground with sugar, sulfur, or other combustible substances as it may explode.

Derivation: by electrolyzing a hot, concentrated alkaline solution of potassium chloride

Grade: USP

Uses in photography: Potassum carbonate is sometimes used in the sensitizer for platinotype paper to give brilliance to the image. Its principal use, however, is in flashlight mixtures. In process work it is used with hydrochloric acid as an etching solution for copper and steel, known as the dutch mordant.

POTASSIUM CHLORIDE, KCl

French, chlorure de potasse; German, Chlorkalium

Synonyms: ------

Atomic weight, ------
Boiling point, decomposes at about 400 °C
Melting point, 772 °C
Molecular weight, 745
Specific gravity, 1.987

Solubility: soluble in water and alkalis; slightly soluble in alcohol; insoluble in absolute alcohol

Properties: colorless or white crystals or powder with a strong saline taste

Derivation: by neutralizing hydrochloric acid with potassium carbonate

Grade: granular

Uses in photography: Potassium chloride is used in making emulsions.

POTASSIUM CHLOROPLATINITE, K_2PtCl_4

French, chloroplatinite de potassium; German, Platinchloruskalium

Synonyms: chloroplatinite; platinochloride of potash

Atomic weight, ------ Molecular weight, 413.4
Boiling point, ------ Specific gravity, 3.291
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: ruby-red, deliquescent crystals

Derivation: by adding potassium carbonate to a solution of chloroplatinous acid

Grade: special photographic

Uses in photography: Potassium chloroplatinite is used in the platinotype process and as one of the ingredients of toning baths for silver prints.

POTASSIUM CHROMATE, K_2CrO_4

French, chromate de potasse; German, Chromsäures kalium

Synonyms: neutral or yellowish chromate of potash

Atomic weight, ------ Molecular weight, 194
Boiling point, ------ Specific gravity, 2.7319
Melting point, 971 °C

Solubility: soluble in water; insoluble in alcohol

Properties: yellow crystals

Derivation: by adding potassium carbonate to a solution of potassium bichromate and crystallizing

Grade: technical

Uses in photography: Potassium chromate is sometimes used as a liquid light filter in sensitometry or three-color work. In process work the chromate has been used as a sensitizer in place of bichromates but is not satisfactory.

POTASSIUM CITRATE, $K_3C_4H_5O_7H_2O$

French, citrate de potasse; German, Citronensäures kalium

Synonyms: tribasic citrate of potash

Atomic weight, ------ Molecular weight, 342
Boiling point, ------ Specific gravity, 1.98
Melting point, decomposes when heated to about 230 °C

Solubility: soluble in water and alcohol

Properties: colorless or white crystals or powder; extremely deliquescent

Derivation: by citric acid acting on potassium carbonate

Grade: USP

Uses in photography: Potassium citrate is used as a restrainer in alkaline development and in several of the copper toning baths. Because of its deliquescence it is best to prepare this salt in solution. The stronger the solution, the better it will keep: dilute solutions soon grown a fungus.

POTASSIUM CYANIDE, KCN

French, cyanure de potassium; German, Cyankalium

Synonyms: cyanide of potash, cyanide

Atomic weight, ------ Molecular weight, 65
Boiling point, at red heat Specific gravity, 1.52
Melting point, at red heat

Solubility: soluble in water, alcohol, and glycerin

Properties: white, amorphous, deliquescent lumps or crystalline mass with the faint odor of bitter almonds; extremely poisonous. Do not handle with bare hands!

Derivation: by fusing potassium ferrocyanide with potassium carbonate in an iron crucible

Grade: pure granulated

Uses in photography: Potassum cyanide is used as a fixing agent in collodion processes and sometimes as a clearing agent for bromide prints. It is also used in Monckhoven's intensifier. In process work it is used for fixing wet

collodion negatives and for cutting or reducing solutions. Potassium cyanide is also used in connection with electrodeposition and for degreasing articles before plating.

POTASSIUM FERRIC OXALATE, $Fe(C_2O_4)_3K_33H_2O$

French, oxalate potassico-ferrique; German, Kalium-ferri-oxalat

Synonyms: ------

Atomic weight, ------ Molecular weight, 491
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: bright green crystals

Derivation: by acidulating potassium ferrous oxalate and exposing it to light

Grade: ------

Uses in photography: Potassium ferric oxalate is used in Belitski's reducer and in several iron printing processes.

POTASSIUM FERRICYANIDE, $K_3Fe(CN)_6$

French, cyanoferride de potassium; German, Ferrid-cyan-kalium

Synonyms: ferricyanide of potash; red prussiate of potash

Atomic weight, ------ Molecular weight, 329
Boiling point, ------ Specific gravity, 1.8109
Melting point, decomposes when heated

Solubility: soluble in water; slightly soluble in alcohol

Properties: bright-red lustrous crystals that often become coated with a yellowish powder. Wash this powder off before using. Poisonous.

Derivation: by passing chlorine into a solution of potassium ferrocyanide and separating out the ferricyanide

Grade: pure crystals

Uses in photography: Potassium ferricyanide is used in several iron printing processes, but its principal use is in conjunction with hypo to form Farmer's reducer. It is used with potassium bromide for bleaching bromide or gaslight prints prior to sulfiding. In process work it is one of the ingredients of the lead nitrate intensifier.

POTASSIUM FERROCYANIDE, $K_4Fe(CN)_63H_2O$

French, cyanoferrure de potassium; German, Gerrocyankalium

Synonyms: ferrocyanide of potash; yellow prussiate of potash

Atomic weight, ------ Molecular weight, 422
Boiling point, decomposes at red heat Specific gravity, ------
Melting point, loses its water of crystallization at 60 °C

Solubility: soluble in water; insoluble in alcohol

Properties: lemon-yellow crystals or powder; effloresces on exposure to air

Derivation: by fusing potassium carbonate with horn clippings and stirring with an iron agitator

Grade: USP

Uses in photography: Potassium ferrocyanide is used as a developer in some iron printing processes. Adding a small amount to pyro and hydroquinone developers has been recommended as a means of lowering fog and giving greater density. A weak solution is used as one of the test reagents for identifying iron and other metallic spots in raw paper stock.

POTASSIUM FLUORIDE, $KF2H_2O$

French, fluorure de potassium; German, Fluorkalium

Synonyms: ------

Atomic weight, ------ Molecular weight, 94
Boiling point, ------ Specific gravity, ------
Melting point, 41 °C

Solubility: soluble in water and hydrofluoric acid; insoluble in alcohol

Properties: white crystalline, deliquescent powder with a sharp saline taste

Derivation: by saturating hydrofluoric acid with potassium carbonate

Grade: technical

Uses in photography: Potassium fluoride is used for stripping films from glass negatives. A 5-min immersion in a 2 percent solution with subsequent immersion in a 2 percent solution of sulfuric acid is sufficient. It keeps better than hydrofluoric acid and does not as strongly attack the skin, lungs, or mucous membranes.

POTASSIUM HYDRATE, KOH

French, potasse caustique; German, Aetzkali

Synonyms: caustic potash, potassium hydroxide

Atomic weight, ------ Molecular weight, 56
Boiling point, sublimes when heated above melting point Specific gravity, 2.044
Melting point, 360.4 °C

Solubility: soluble in water and alcohol; slightly soluble in ether

Properties: white, deliquescent lumps or sticks; poisonous. Because it readily attacks corks and glass stoppers, these should be waxed or paraffined. Must not be handled because it is a very powerful escharotic inflicting severe burns upon the skin.

Derivation: by decomposing potassium carbonate with milk of lime

Grade: ------

Uses in photography: Potassium hydrate is used as an accelerator in alkaline development. In process work crude caustic potash is used for cleaning old negative glasses and for taking the ink and resist off copper and zinc plates after etching. It is also used for cleaning articles before electroplating.

POTASSIUM IODIDE, KI

French, iodure de potassium; German, Iodkali

Synonyms: iodide of potash

Atomic weight, ------ Molecular weight, 166
Boiling point, 1420 °C Specific gravity, 3.123
Melting point, 680 °C

Solubility: soluble in water, alcohol, and ether

Properties: white crystals, granules, or powder with a strong, bitter, saline taste

Derivation: by treating a hot solution of potassium hydroxide with iodine, evaporating to dryness, mixing with carbon, and heating to redness

Grade: USP

Uses in photography: Potassium iodide is used in preparing mercuric iodide intensifier. Used in emulsion-making, particularly in conjunction with gelatinobromide emulsions, it reduces emulsion fog, enhances contrast, and increases density. Using more than a small percentage, however, yields an emulsion that is slow in fixing. It is generally conceded that a complex double salt of bromoiodide of silver is formed and is responsible for the particular character and photographic quality of bromoiodide emulsions. A very small amount of a

1 percent solution added to a finished emulsion enormously decreases its speed. It is also used in some of the more modern dye mordanting processes.

POTASSIUM METABISULFITE, $K_2S_2O_5$

French, metabisulfite de potassium; German, Kaliummetabisulfit

Synonyms: metabisulfite of potash; potassium pyrosulfite

Atomic weight, ------ Molecular weight, 222
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: slightly soluble in water; insoluble in alcohol

Properties: clear, transparent crystals smelling of sulfurous acid gas

Derivation: by heating potassium bisulfite until it loses water

Grade: granular photographic

Uses in photography: Potassium metabisulfite is used as a preservative in developers and for acidulating hypo baths. Lately sodium metabisulfite has been introduced to take the place of the potassium salt.

POTASSIUM NITRATE, KNO_3

French, azotate de potasse; German, Salpetersäures kali

Synonyms: nitrate of potash; niter; saltpeter

Atomic weight, ------ Molecular weight, 101
Boiling point, decomposes with deflagration at about 400 °C Specific gravity, 2.1062
Melting point, 337 °C

Solubility: soluble in water; insoluble in alcohol and ether

Properties: transparent, colorless or white crystalline powder or crystals with cooling, pungent, saline taste

Derivation: by evaporating sodium nitrate and potassium chloride in solution until sodium chloride crystallizes out and then decanting and crystallizing.

Grade: USP

Uses in photography: Potassium nitrate is used in manufacturing pyroxyline and flash powders. It has been recommended as an addition to emulsions to prevent fog.

POTASSIUM OXALATE, $K_2C_2O_4H_2O$

French, oxalate neutre de potasse; German, neutrales Oxalsäures kali and Kaliumoxalat

Synonyms: neutral oxalate of potash

Atomic weight, ------ Molecular weight, 184
Boiling point, ------ Specific gravity, 2.08
Melting point, decomposes when heated

Solubility: soluble in water; insoluble in alcohol and ether

Properties: colorless, transparent crystals

Derivation: by saturating acid oxalate of potash, or oxalic acid, with potassium carbonate

Grade: photographic

Uses in photography: Potassium oxalate is used in ferrous oxalate developer and as a developer for platinotypes.

POTASSIUM PERCARBONATE, $K_2C_2O_4H_2O$

French, percarbonate de potasse; German, Kaliumpercarbonat

Synonyms: ------

Atomic weight, ------ Molecular weight, 216
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: slightly soluble in water

Properties: white, crystalline powder

Derivation: by electrolysis of potassium carbonate

Grade: technical

Uses in photography: Potassium percarbonate is used as a hypo eliminator and has been sold under many trade names.

POTASSIUM PERCHLORATE, $KClO_4$

French, perchlorure de potassium; German, Ueberchlorsäures kali

Synonyms: ------

Atomic weight, ------ Molecular weight, 138.5
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: slightly soluble in water; insoluble in alcohol

Properties: colorless powder or rhombic crystals

Derivation: ------

Grade: technical

Uses in photography: Potassium perchlorate is used in flashlight mixtures. It should be mixed with the same precaution as potassium chlorate.

POTASSIUM PERMANGANATE, $KMnO_4$

French, permanganate de potasse; German, Uebermangansäures kali

Synonyms: permanganate of potash

Atomic weight, ------ Molecular weight, 158
Boiling point, ------ Specific gravity, 2.7032
Melting point, decomposes at 240 °C

Solubility: soluble in water, sulfuric and acetic acids, and alcohol

Properties: dark-purple crystals with a blue metallic sheen and a sweetish, astringent taste

Derivation: by fusing manganese peroxide with potassium hydrate or nitrate

Grade: USP

Uses in photography: Potassium permanganate is used as a reducer for negatives. When acidulated with sulfuric acid, it reduces highlights more than shadows. Used as a neutral solution, it to all intents and purposes is an intensifier since a manganese salt is precipitated on the silver image, rendering it slightly nonactinic in color. It is used as the reverser in several screen-plate color processes, as a test for the presence of hypo, and as a hypo eliminator. In process work a small amount of a 10 percent solution rids a wet collodion silver bath of organic impurities.

POTASSIUM PERSULFATE, K_2S_2O

French, persulphate de potasse; German, Ueberschwefelsäures kali

Synonyms: persulfate of potash; anthion

Atomic weight, ------ Molecular weight, 270
Boiling point, ------ Specific gravity, -----
Melting point, decomposes below 100 °C

Solubility: soluble in water; insoluble in alcohol

Properties: white crystals

Derivation: by electrolysis of a saturated solution of potassium sulfate

Grade: technical

Uses in photography: Potassium persulfate is used as a hypo eliminator and has been sold under various trade names. It may also be used as a reducer in place of ammonium persulfate and is less likely to contain injurious impurities.

POTASSIUM AND SODIUM TARTRATE, $KNaC_4H_4O_64H_2O$

French, sel de seignette; German, Seignettesalz, Rochellesalz, and Weinsäures kalintron

Synonyms: rochelle or seignette salts

Atomic weight, ------ Molecular weight, 282
Boiling point, loses $4H_2O$ at 215 °C Specific gravity, 1.77
Melting point, 70 to 80 °C

Solubility: soluble in water; insoluble in alcohol

Properties: colorless, transparent crystals or white powder

Derivation: by boiling together cream of tartar and sodium carbonate

Grade: USP

Uses in photography: Potassium and sodium tartrate is used in printing-out emulsions to form silver tartrate.

POTASSIUM SULFIDE, K_2S_2

French, foie de soufre; German, Schwefelkalium and Schwefelleber

Synonyms: liver of sulfurated potash; potassium trisulfide

Atomic weight, ------ Molecular weight, 174
Boiling point, ------ Specific gravity, 1.805
Melting point, -----

Solubility: soluble in water, alcohol, and glycerin; insoluble in ether

Properties: deliquescent, red, crystalline mass. Should be kept in well-stoppered bottles.

Derivation: by fusing sulfur and potassium carbonate

Grade: technical

Uses in photography: Potassium sulfide was used to precipitate the silver from waste photographic solutions but recently has been almost entirely replaced for this purpose by sodium sulfide.

POTASSIUM SULFOCYANIDE, KCNS

French, sulfocyanure de potassaiu; German, Rhodankalium and Schwefekyankalium

Synonyms: potassium thiocyanate; sulfocyanate; rhodanide

Atomic weight, ------
Boiling point, decomposes at 500 °C
Melting point, 172.3 °C
Molecular weight, 97
Specific gravity, 1.906

Solubility: soluble in water, alcohol, and acetone

Properties: transparent, deliquescent crystals. Must be kept in well-stoppered bottles.

Derivation: by heating potassium cyanide with sulfur

Grade: pure

Uses in photography: Potassium sulfocyanide is used in the sulfocyanide toning bath. It is a solvent for gelatin and has therefore been used to develop overexposed carbon prints.

SILVER ACETATE, $AgC_2H_2O_2$

French, acètate de'argent; German, Silberacetat

Synonyms: ------

Atomic weight, ------
Boiling point, ------
Melting point, ------
Molecular weight, 167
Specific gravity, ------

Solubility: soluble in water; insoluble in alcohol

Properties: fine white powder or crystals

Derivation: by adding an alkaline acetate to silver nitrate solution or by dissolving silver carbonate in glacial acetic acid

Grade: ------

Uses in photography: Silver acetat has been recommended for use in printing-out papers, but it yields a poor-quality image and is about one-twentieth as sensitive as silver chloride.

SILVER AMMONIO-CARBONATE, $Ag_2CO_34NH_3$

French, ammonio-carbonate d'argent; German, Kohlensäures silberoxydammoniak

Synonyms: ------

Atomic weight, ------ Molecular weight, 229
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and alcohol

Properties: not found in the solid form

Derivation: by adding a solution of ammonium carbonate to a solution of silver nitrate

Grade: ------

Uses in photography: Silver ammonium-carbonate is sometimes used in making emulsions, particularly positive or lantern slide emulsions.

SILVER AMMONIO-NITRATE, $AgNO_32NH_3$

French, ammonio-nitrate d'argent; German, Salpetersäures silberoxydammoniak

Synonyms: ammonio-oxide of silver

Atomic weight, ------ Molecular weight, 204
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and alcohol

Properties: colorless needles; but rarely exists in the solid form, being formed in the ammonio-nitrate emulsion-making processes

Derivation: by mixing a solution of ammonia with silver nitrate until the precipitate first formed is redissolved

Grade: ------

Uses in photography: A solution of silver ammonio-nitrate is sometimes used for sensitizing plain paper, but its principal use is to form silver bromide in emulsion-making. Emulsions prepared by the ammonio-nitrate process do not have to be ripened by heating because the ammonia takes the place of heat.

SILVER BROMIDE, AgBr

French, bromure d'argent; German, Bromsilber

Synonyms: bromide of silver

Atomic weight, ------ Molecular weight, 188
Boiling point, decomposes at 700 °C Specific gravity, 6.473
Melting point, 427 °C

Solubility: soluble in sodium thiosulfate, potassium bromide, and potassium cyanide solutions; practically insoluble in water and ammonium hydroxide

Properties: yellow, amorphous powder

Derivation: by adding any soluble bromide to silver nitrate solution. In photography it is always prepared in the presence of some vehicle that will suspend it in the form of an emulsion and prevent it from forming coarse clots.

Grade: ------

Uses in photography: Silver bromide is the basis of the modern gelatino-bromide emulsions and is the most light-sensitive silver salt.

SILVER CARBONATE, Ag_2CO_2

French, carbonate d'argent; German, Kohlensäures silberoxyd

Synonyms: ------

Atomic weight, ------ Molecular weight, 276
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in potassium cyanide, ammonia, and sodium thiosulfate; insoluble in water and alcohol

Properties: yellow, granular powder

Derivation: by adding an alkaline carbonate to silver nitrate solution

Grade: ------

Uses in photography: Silver carbonate is sometimes formed in preparing printing-out, gaslight, and negative emulsions.

SILVER CHLORIDE, AgCl

French, chlorure d'argent; German, Chlorsilber

Synonyms: chloride of silver; horn silver; muriate of silver

Atomic weight, ------ Molecular weight, 143.5
Boiling point, ------ Specific gravity, 5.561
Melting point, 451 °C

Solubility: soluble in sodium thiosulfate and potassium bromide solutions, concentrated sulfuric acid, and ammonium hydroxide; practically insoluble in water

Properties: white, granular powder that darkens on exposure to light, finally turning black

Derivation: by adding a soluble chloride to silver nitrate solution

Grade: ------

Uses in photography: Silver chloride is formed in preparing printing-out emulsions and positive emulsions. The higher the proportion of silver chloride in an emulsion, the shorter the gradation scale.

SILVER CHROMATE, Ag_2CrO_4

French, chromate d'argent; German, Silberchromat

Synonyms: ------

Atomic weight, ------ Molecular weight, 332
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in ammonia and sodium thiosulfate; insoluble in water, alcohol, and ether

Properties: red, amorphous powder

Derivation: by adding potassium chromate to silver nitrate solution

Grade: ------

Uses in photography: The formation of a small amount of silver chromate salt in the printing-out emulsion reduces the scale of gradation and makes a more contrasty paper suitable for weak negatives.

SILVER CITRATE, $AgC_6H_5O_7$

French, citrate d'argent; German, Silbercitrate and Citronensäures silberoxyd

Synonyms: citrate of silver

Atomic weight, ------ Molecular weight, 297
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in ammonia, sodium thiosulfate, and potassium cyanide; insoluble in water, alcohol, and ether

Properties: curdy, white powder

Derivation: by adding an alkaline citrate to silver nitrate solution

Grade: ------

Uses in photography: When formed in small proportions in printing-out emulsions, silver citrate has a definite influence on the keeping quality of the paper. It seems to have a preservative effect. Formed in silver chloride gaslight emulsions, it tends to enhance contrast and reduce fog.

SILVER CYANIDE, AgCN

French, cyanure d'argent; German, Silbercyanid

Synonyms: ------

Atomic weight, ------ Molecular weight, 134
Boiling point, ------ Specific gravity, 3.95
Melting point, decomposes when heated

Solubility: soluble in ammonia, potassium cyanide, and sodium thiosulfate solutions; insoluble in water, alcohol, and ether

Properties: white powder that darkens on exposure to light; very poisonous

Derivation: obtained by adding an alkaline cyanide to a solution of silver nitrate

Grade: ------

Uses in photography: Silver cyanide is formed in preparing the blackening solution in Monckhoven's intensifier.

SILVER IODIDE, AgI

French, iodure d'argent; German, Iodsilber

Synonyms: ------

Atomic weight, ------ Molecular weight, 235
Boiling point, ------ Specific gravity, 5.675
Melting point, 556 °C

Solubility: soluble in potassium cyanide and sodium thiosulfate solutions; insoluble in water, ammonia, alcohol, and ether.

Properties: pale-yellow powder, darkening on exposure to light

Derivation: by adding a soluble iodide to silver nitrate solution

Grade: ------

Uses in photography: Silver iodide is sometimes formed in small proportions in gelatinobromide emulsions. It tends to restrain fog during digestion and produces greater sensitiveness (see "POTASSIUM IODIDE"). Silver iodide is also employed in the wet-plate process. The negative silver bath for sensitizing wet collodion plates should be saturated with silver iodide before using.

SILVER NITRATE, $AgNO_3$

French, azotate d'argent; German, Silbernitrat and Salpetersäures silber

Synonyms: ------

Atomic weight, ------ Molecular weight, 170
Boiling point, decomposes Specific gravity, 4.352
Melting point, 218 °C

Solubility: soluble in water, ether, and glycerin; slightly soluble in alcohol

Properties: colorless, rhombic plates; not in itself sensitive to light but easily reduced to the metallic state in the presence of organic materials such as skin, paper, or gelatin

Derivation: by dissolving silver in dilute nitric acid and evaporating the solution.

Grade: pure crystals; photographic

Uses in photography: Silver nitrate is the salt from which are made all the sensitive materials of photography in which silver is used. In process work it is occasionally used in the etching bath for steel plates.

SILVER PHOSPHATE, Ag_3PO_4

French, phosphate d'argent; German, Silberphosphat

Synonyms: normal silver orthophosphat

Atomic weight, ------ Molecular weight, 419
Boiling point, ------ Specific gravity, 7.321
Melting point, 849 °C

Solubility: soluble in ammonia, potassium cyanide, and sodium thiosulfate solutions and in organic acids; insoluble in water, alcohol, and ether

Properties: heavy, yellow powder; turns brown when heated or on exposure to light

Derivation: by adding phosphoric acid to silver nitrate solution

Grade: ------

Uses in photography: When formed in small proportions in printing-out emulsions, silver phosphate gives a long scale of gradation suitable for

making soft prints from hard negatives. It acts similarly when formed in silver chloride gaslight emulsions.

SILVER SULFIDE, Ag_2S

French, sulfure d'argent; German, Silbersulfid

Synonyms: ------

Atomic weight, ------ Molecular weight, 248
Boiling point, decomposes Specific gravity, 6.85 to 7.32
Melting point, 842 °C

Solubility: soluble in concentrated sulfuric and nitric acids; insoluble in water and alcohol

Properties: brownish-black powder

Derivation: by mixing an alkaline sulfide with silver nitrate solution. Also formed when liver of sulfur is added to old hypo baths.

Grade: ------

Uses in photography: Silver sulfide is the salt formed when gaslight or bromide prints are sepia toned in a sulfide bath.

SODIUM ACETATE, $NaC_2H_2O_23H_2O$

French, acètate de soude; German, Essigsäures natron

Synonyms: acetate of soda

Atomic weight, ------ Molecular weight, 136
Boiling point, ------ Specific gravity, 1.4
Melting point, 58 °C

Solubility: soluble in water; slightly soluble in alcohol

Properties: colorless, transparent, efflorescent crystals

Derivation: prepared by neutralizing acetic acid with sodium carbonate

Grade: USP granulated

Uses in photography: Sodium acetate is used in the gold toning bath. Double-fused sodium acetate is sometimes used. Having a slight alkaline reaction, it makes the toning bath work more quickly. It is also more free of organic impurities.

SODIUM BICHROMATE, $Na_2Cr_2O_72H_2O$

French, bichromate de soude; German, doppelt Chromsäures natron

Synonyms: dichromate of soda; acid sodium chromate

Atomic weight, ------ Molecular weight, 298
Boiling point, decomposes Specific gravity, 2.52
Melting point, loses
$2H_2O$ at 100 °C

Solubility: soluble in water; insoluble in alcohol

Properties: red, deliquescent, crystalline fragments

Derivation: obtained in similar manner to potassium sulfocyanide

Grade: technical

Uses in photography: Sodium bichromate is used in the same manner and for the same purposes as the potassium sulfocyanide. One part of potassium bichromate is equivalent to 1.10 parts of sodium bichromate. In process work sodium bichromate is sometimes used to replace the ammonium and potassium salts for sensitizing, but its deliquescent nature is a disadvantage.

SODIUM BISULFITE, $NaHSO_3$

French, bisulfite de saude; German, Säures Schwefeligsäures natron, natrium Bisulfit

Synonyms: acid sulfite of soda

Atomic weight, ------ Molecular weight, 104
Boiling point, ------ Specific gravity, 1.48
Melting point, decomposes

Solubility: soluble in water; insoluble in alcohol

Properties: white, crystalline powder with faint sulfurous odor

Derivation: by passing sulfurous acid gas through carbonate of soda solution

Grade: USP or special photographic

Uses in photography: Sodium bisulfite is used for acidulating and preserving fixing baths, supplying both the sulfite and acid necessary. It is also used for preparing neutral sulfite solution, which is extensively used as a preservative for pyro developer, and can be substituted weight-for-weight for potassium metabisulfite. For photographic purposes sodium bisulfite should be free from iron.

SODIUM BORATE, $Na_2B_4O_710H_2O$

French, borate de soude; German, Borax and Borsäures natron

Synonyms: borax; sodium tetraborate; pyroborate; biborate

C-2

Atomic weight, ------ Molecular weight, 382
Boiling point, ------ Specific gravity, ------
Melting point, red heat

Solubility: soluble in water and glycerine; insoluble in alcohol

Properties: white crystals or powder

Derivation: obtained from the native borax or by neutralization of native boric acid

Grade: USP

Uses in photography: Sodium borate is used in gold toning baths and as an accelerator with hydroquinone and eikonogen developers. It can be used as a restrainer with the Metol-hydroquinone developer for gaslight papers and produces a warm brownish-black print.

SODIUM CARBONATE, $Na_2CO_3 10H_2O$ (CRYSTALS) Na_2Co_2 (DRY)

French, carbonate de soude; German, Soda, Kohlensäures natron, and natriumcarbonat

Synonyms: soda; washing soda; carbonate of soda

Atomic weight, ------ Molecular weight, 286
Boiling point, 106 °C Specific gravity, 1.446
Melting point, loses
$5H_2O$ at 125 °C and
melts at 34 °C

Solubility: soluble in water and glycerin; insoluble in alcohol

Properties: colorless crystals or white powder with a strong alkaline taste; effloresces in air

Derivation: by converting salt into sodium sulfate and then decomposing the latter by roasting with limestone and coal

Grade: USP

Uses in photography: Sodium carbonate is the principal alkali used for developers; in addition to the crystal form there is a grade known as dry powder, which is extensively used. For all practical work 37 parts of the dry powder are equivalent to 100 of the crystals.

SODIUM CHLORIDE, NaCl

French, chlorure de soude and selmarin; German, Chlornatrium and Sal Germmae

Synonyms: muriate or chloride of soda; salt; common table salt

Atomic weight, ------ Molecular weight, 58.5
Boiling point, 1490 °C Specific gravity, 2.161
Melting point, 804 °C

Solubility: soluble in water; practically insoluble in alcohol; insoluble in concentrated hydrochloric acid

Properties: colorless, transparent crystals or white, crystalline powder

Derivation: obtained in native state or by purification from sea water

Grade: USP

Uses in photography: Sodium chloride is used in preparing chloride emulsions. It also acts as a restrainer but is weaker than the alkaline bromides.

SODIUM CITRATE, $2Na_3C_4H_5O_7 \cdot 11H_2O$

French, citrate de soude; German, Citronensäures natron

Synonyms: citrate of soda; neutral citrate of soda

Atomic weight, ------ Molecular weight, 714
Boiling point, decomposes Specific gravity, ------
Melting point, loses
$11H_2O$ at 150 °C

Solubility: soluble in water; slightly soluble in alcohol

Properties: white crystals or granular powder with a pleasant acid taste; very deliquescent

Derivation: by neutralizing citric acid with sodium carbonate

Grade: USP

Uses in photography: Sodium citrate is used as a preservative in albumen papers and to form silver citrate in printing-out emulsions. It is also used as a restrainer in development.

SODIUM HYDRATE (CAUSTIC), NaOH

French, soude caustique; German, Aetznatron

Synonyms: caustic soda; sodium hydroxide

Atomic weight, ------ Molecular weight, 40
Boiling point, white heat Specific gravity, 2.13
Melting point, 318 °C

Solubility: soluble in water, alcohol, and glycerin

Properties: white, deliquescent pieces, lumps, or sticks; crystalline fracture. Keep well stoppered, absorbs water and carbon dioxide from the air. Should not be handled with the fingers.

Derivation: by decomposing sodium carbonate with lime

Grade: USP

Uses in photography: Sodium hydrate is used as an accelerator in development, most generally with low-energy developers, as hydroquinone, etc.

SODIUM NITRATE, $NaNo_3$

French, azotate de soude; German, Salpetersäures natron

Synonyms: cubic, chili, or soda niter or saltpeter

Atomic weight, ------ Molecular weight, 85
Boiling point, decomposes Specific gravity, 2.267
Melting point, 316 °C

Solubility: soluble in water and glycerin; slightly soluble in alcohol

Properties: colorless, transparent crystals

Derivation: found native

Grade: USP

Uses in photography: Sodium nitrate is not often used in photography although it is credited with imparting a brownish-black tone to developed silver images.

SODIUM NITRITE, $NaNO_3$

French, azotite de soude; German, Salpetrigsäures natron

Synonyms: nitrite of soda

Atomic weight, ------ Molecular weight, 69
Boiling point, decomposes Specific gravity, 2.157
Melting point, 213 °C

Solubility: soluble in water; slightly soluble in alcohol and ether

Properties: slightly yellowish or white crystals

Derivation: by fusing the nitrate or neutralizing nitrous acid

Grade: USP

Uses in photography: Sodium nitrite is used in the diazotype process and in preparing photometer paper.

SODIUM NITROPRUSSIDE, $Na_4Fe(CN)_5(NO)2H_2O$

French, nitroprussiate de soude; German, Nitroprussidnatrium

Synonyms: sodium nitroprussiate

Atomic weight, ------ Molecular weight, 298
Boiling point, ------ Specific gravity, 1.6803
Melting point, ------

Solubility: soluble in water and alcohol

Properties: ruby-red, transparent crystals

Derivation: by treating sodium ferrocyanide solution with nitric acid

Grade: pure

Uses in photography: Sodium nitorprusside is one of the most light-sensitive iron salts and is sometimes used in iron printing processes.

SODIUM OXALATE, $Na_2C_2O_4$

French, oxalate de soude; German, Oxalsäures natron

Synonyms: oxalate of soda
Atomic weight, ------ Molecular weight, 134
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: white, crystalline powder; poisonous

Derivation: by neutralizing an oxalic acid solution with sodium carbonate

Grade: pure

Uses in photography: Sodium oxalate is not often used because of its low solubility but sometimes used in the platinotype process.

SODIUM PHOSPHATE, $Na_2HPO_4 12H_2O$

French, phosphate de soude; German, Phosphorsäures natron

Synonyms: disodium phosphate, disodium orthophosphate

Atomic weight, ------ Molecular weight, 358
Boiling point, loses $12H_2O$ at 100 °C Specific gravity, 1.5235
Melting point, 35 °C

Solubility: soluble in water; insoluble in alcohol

Properties: colorless, transparent crystals

Derivation: by treating calcium phosphate with carbonate of soda

Grade: USP

Uses in photography: Sodium phosphate is used in gold toning baths and sometimes in making silver chloride emulsions.

SODIUM SILICATE, Na_3SiO_3

French, silicate de soude; German, Natronwasserglas

Synonyms: soluble glass; soda water-glass

Atomic weight, ------ Molecular weight, 124
Boiling point, ------ Specific gravity, ------
Melting point, 1018 °C

Solubility: soluble in water and alkalis; insoluble in alcohol and acids

Properties: white to gray-white lumps or powder; also obtainable in a commercial form as a syrupy, yellowish liquid

Derivation: by heating silica, calcined soda, and coal together in a crucible, extracting the mass when cold with water, and evaporating the water

Grade: usually bought in the grade known as technical solution

Uses in photography: Sodium silicate is used principally in process work, either alone or with albumen to form a substratum for coating collotype printing plates.

SODIUM SULFANTIMONIATE, $Na_3SbS_49H_2O$

French, sulfoantimoniate de soude and sel de schlippe; German, Schlippersche salz

Synonyms: Schlippe's salt; sodium thiantimonate

Atomic weight, ------ Molecular weight, 479
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water

Properties: colorless or yellow crystals

Derivation: obtained by boiling sulfide of antimony, milk of lime, and sodium carbonate

Grade: pure

Uses in photography: Sodium sulfantimoniate is used for blackening negatives after bleaching with mercuric chloride and is sometimes used for toning bromide prints.

SODIUM SULFATE, $Na_2SO_4 10H_2O$

French, sulfate de soude; German, Schwefelsäures natron

Synonyms: Glauber's salt

Atomic weight, ------ Molecular weight, 322
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; insoluble in alcohol

Properties: colorless, efflorescent crystals

Derivation: a byproduct in the salt cake process

Grade: technical

Uses in photography: Sodium sulfate finds considerable use in preparing barium sulfate for surface coating photographic raw paper stock.

SODIUM SULFIDE, $Na_2S 9H_2O$

French, sulfure de soude; German, Natrimsulfid

Synonyms: sulfide of soda

Atomic weight, ------ Molecular weight, 240
Boiling point, ------ Specific gravity, 1.856
Melting point, ------

Solubility: soluble in water; slightly soluble in alcohol; insoluble in ether

Properties: yellow or brick-red lumps; deliquescent. Must be kept well stoppered.

Derivation: by fusing sodium carbonate with sulfur

Grade: technical

Uses in photography: Sodium sulfide is used for the sulfide toning of bromide and gaslight prints. Sodium sulfide should not be kept near sensitive materials as it is likely to fog them and bring about deterioration. In process work a 3 to 5 percent solution is used as the blackening agent in intensifying wet collodion negatives; for this purpose it is better than ammonium sulfide.

SODIUM SULFITE, $Na_2SO_37H_2O$ (CRYSTALS) OR Na_2So_3 (DRY)

French, sulfite de soude; German, Natriumsulfid

Synonyms: sulfite of soda

Atomic weight, ------ Molecular weight, 252
Boiling point, decomposes Specific gravity, 1.5939
Melting point, loses
$7H_2O$ at 190 °C

Solubility: soluble in water; insoluble in alcohol

Properties: white crystals or powder. The crystals are efflorescent, becoming readily oxidized to sulfate.

Derivation: by passing sulfurous acid gas over moistened sodium carbonate

Grade: USP (crystals or dry powder)

Uses in photography: Sodium sulfite is a vigorous absorbent of oxygen; therefore it is used as a preservative of developing agents. It is one of the constituents of the acid fixing bath. The dry powder form, which is now almost universally used in photography, is twice as strong in sulfite as the crystalline.

SODIUM THIOSULFATE, $Na_2S_3O_35H_2O$

French, hyposulfite de soude; German, Fixirnatron and Unterschwefligsäures natron

Synonyms: sodium hyposulfite

Atomic weight, ------ Molecular weight, 248
Boiling point, decomposes Specific gravity, 1.729
Melting point, 48 °C

Solubility: soluble in water and oil of turpentine; insoluble in alcohol

Properties: white, transparent crystals

Derivation: The crude sulfide liquors resulting from the Le Blanc soda process are exposed to air and oxidized to yield calcium thiosulfate. This solution is boiled with sodium sulfate and subsequently crystallized.

Grade: technical

Uses in photography: Sodium thiosulfate is principally used in preparing fixing baths for films, plates, and papers. It is one of the ingredients of Farmer's ferricyanide-hypo reducer.

SODIUM VANADATE, Na_3VO_4

French, vanadate de soude; German, Natriumvanadat

Synonyms: sodium orthovandat

Atomic weight, ------ Molecular weight, 184
Boiling point, ------ Specific gravity, ------
Melting point, 866 °C

Solubility: soluble in water; insoluble in alcohol

Properties: white, crystalline powder

Derivation: by dissolving ammonium vanadate in sodium hydroxide solution and crystallizing

Grade: ------

Uses in photography: Sodium vanadate is sometimes used to increase the contrast of printing-out emulsions.

STARCH, $C_5H_{10}O_5$

French, amidon; German, Starke

Synonyms: ------

Atomic weight, ------ Molecular weight, ------
Boiling point, decomposes and chars Specific gravity, 1.499 to 1.513
Melting point, does not melt

Solubility: insoluble in cold water, alcohol, and ether; makes a jelly with hot water

Properties: white, amorphous powder. Starch when heated to about 204 °C is converted into dextrine.

Derivation: from corn, maze, rice, potatoes, arrow root, etc.

Grade: ------

Uses in photography: Starch is used in preparing photographic mountants and also for sizing photographic paper. It is sometimes used as a matting agent, being added to emulsions to dull the surface.

STRONTIUM BROMIDE, $SrBr6H_2O$

French, bromure de strontium; German, Strontiumbromid

Synonyms: bromide of strontia

Atomic weight, ------ Molecular weight, 355.5
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water; slightly soluble in alcohol

Properties: colorless crystals

Derivation: by neutralizing hydrobromic acid with strontium hydrate

Grade: USP

Uses in photography: Strontium bromide is sometimes used in collodion emulsions to increase contrast. The anhydrous salt, SrBr, is sometimes used and occurs as a white, deliquescent powder.

STRONTIUM CHLORIDE, $SrCl_2 6H_2O$(CRYSTALS) OR $SrCl_2$(DRY)

French, chlorure de strontium; German, Strontiumchlorid

Synonyms: chloride of strontia

Atomic weight, ------ Molecular weight, 266.5
Boiling point, ------ Specific gravity, 1.964
Melting point, loses
$6H_2O$ at 112 °C

Solubility: soluble in water and alcohol

Properties: white needles

Derivation: Calcium chloride is fused with sodium carbonate and the yield is extracted with water, concentrated, and crystallized.

Grade: USP

Uses in photography: Strontium chloride is used in preparing chloride emulsions, yielding more contrast and shorter scale. The anhydrous salt, $SrCl_2$, is sometimes used and occurs as a white powder.

STRONTIUM IODIDE, $SrI_2 6H_2O$

French, iodure de strontium; German, Strontiumiodid

Synonyms: iodide of strontia

Atomic weight, ------ Molecular weight, 449
Boiling point, ------ Specific gravity, 4.415
Melting point, ------

Solubility: soluble in water, alcohol, and ether

Properties: yellowish, granular powder

Derivation: by treating strontium carbonate with hydriodic acid

Grade: USP fused

Uses in photography: The uses of strontium iodide are the same as for strontium bromide.

THIOCARBAMIDE, $CS(NH_2)_2$

French, sulfo-uree and sulfocarbamide; German, Thiocarbamid and Sulfoharnstoff

Synonyms: sulfourea thiourea

Atomic weight, ------ Molecular weight, 76
Boiling point, sublimes in vacuo at 150 to 160 °C Specific gravity, 1.406
Melting point, 180 °C

Solubility: soluble in cold water, ammonium sulfocyanide solution, and ether; insoluble in cold alcohol

Properties: white, lustrous crystals

Derivation: by heating ammonium sulfocyanide for several hours at 161 °C

Grade: ------

Uses in photography: Thiocarbamide is used in the gold toning bath and has been suggested as an addition to eikonogen developer to produce reversal. Thiocarbamide can also be used for clearing yellow stains from prints and plates.

THIOSINAMINE, $CS(NH_2)NHC_3H_5$

French, sulfofenylurèe; German, Thiosinamin allylsulfoharnstoff

Synonyms: allyl sulfocarbamide; allyl sulfourea

Atomic weight, ------ Molecular weight, 116
Boiling point, ------ Specific gravity, -----
Melting point, ------

Solubility: soluble in alcohol and ether; slightly soluble in water

Properties: colorless crystals with a garlic odor

Derivation: by the action of ammonia and alcohol on allyl sulfocyanate (oil of mustard)

Grade: ------

Uses in photography: Thiosinamine has been tried as a fixing agent but is not nearly as energetic as hypo.

TIN (STANNOUS) CHLORIDE, $SnCl_2 2H_2O$

French, chlorure d'etain; German, Stannochlorid

Synonyms: tin protochloride or dichloride; tin salt

Atomic weight, ------ Molecular weight, 225
Boiling point, decomposes Specific gravity, 2.71
Melting point, 37.7 °C

Solubility: soluble in water and alcohol

Properties: white crystals

Derivation: by the action of hydrochloric acid on tin

Grade: technical (crystals)

Uses in photography: Tin chloride can be used as a blackening agent after bleaching with mercuric chloride.

URANIUM CHLORIDE, $UO_2Cl_2H_2O$

French, chlorure d'urane; German, Uranylchlorid

Synonyms: uranyl chloride; oxychloride

Atomic weight, ------ Molecular weight, 361
Boiling point, ------ Specific gravity, ------
Melting point, ------

Solubility: soluble in water and alcohol

Properties: deliquescent, greenish-yellow flakes; poisonous

Derivation: by dissolving uranic oxide in hydrochloric acid

Grade: ------

Uses in photography: Uranium chloride is sometimes used as a sensitive salt for printing-out paper and to enhance the contrast of chloride emulsions.

URANIUM NITRATE, $UO_2(NO_3)_2 6H_2O$

French, azotate d'urane; German, Uranylsalpetersäure

Synonyms: uranyl nitrate; uranium oxynitrate

Atomic weight, ------ Molecular weight, 504
Boiling point, 118 °C Specific gravity, 2.807
Melting point, 602 °C

Solubility: soluble in water, alcohol, and ether; poisonous

Properties: yellow, rhombic crystals; efflorescent; greenish color by reflected light

Derivation: by dissolving uranic oxide in nitric acid

Grade: USP

Uses in photography: Uranium nitrate is used in printing-out emulsions and with potassium ferricyanide in toning bromide prints and intensifying negatives. It is also used in conjunction with silver nitrate in preparing uranium silver papers for gaslight printing and in the uranium mercuro-uranotype and platino-uranotype processes.

VANADIUM CHLORIDE, $2VO_24HC13H_2O$

French, chlorure de vanade; German, Chlorvanadium

Synonyms: hypovanadic-hydrochloride; divanadyl-tetrachloride

Atomic weight, ------ Molecular weight, 366
Boiling point, ------ Specific gravity, 3.23
Melting point, -----

Solubility: soluble in water and alcohol

Properties: dark-green, syrupy mass; poisonous

Derivation: by dissolving vanadic anhydride in hydrochloric acid

Grade: -----

Uses in photography: Vanadium chloride is used for imparting a green tone to bromide prints and is one of the ingredients of the Donisthorpe dye printing process. Lumière, in 1894, introduced a vanadium printing process in which a gelatinized paper was sensitized with a mixture of vanadium chloride in alcohol and water, printed under a positive transparency, and subsequently treated with paramidophenol.

ZINC BROMIDE, $ZnBr_2$

French, bromure de zinc; German, Zinkbromid

Synonyms: ------

Atomic weight, ------ Molecular weight, 225
Boiling point, 650 °C Specific gravity, 4.219
Melting point, 394 °C

Solubility: soluble in water, alcohol, and ether

Properties: white, hygroscopic, crystalline powder

Derivation: by dissolving zinc carbonate in hydrobromic acid

Grade: USP

Uses in photography: Zinc bromide is used in preparing collodion emulsions.

ZINC CHLORIDE, $ZnCl_2$

French, chlorure de zinc; German, Zinkchlorid

Synonyms: ------

Atomic weight, ------ Molecular weight, 136
Boiling point, 730 °C Specific gravity, 2.91
Melting point, 262 °C

Solubility: soluble in water, alcohol, and ether

Properties: white, granular, deliquescent crystals; poisonous. Keep in well-stoppered bottles.

Derivation: hydrochloric acid acting on zinc, with subsequent crystallization

Grade: USP

Uses in photography: Zinc chloride is used in preparing collodion emulsions.

ZINC IODIDE, ZnI_2

French, iodure de zinc; German, Zinkiodid

Synonyms: ------

Atomic weight, ------ Molecular weight, 319
Boiling point, 624 °C Specific gravity, 4.696
Melting point, 446 °C

Solubility: soluble in water, alcohol, and ether

Properties: white, deliquescent powder. Keep in well-stoppered bottles.

Derivation: by dissolving zinc oxide in iodic acid

Grade: USP

Uses in photography: Zinc iodide is used in preparing collodion emulsions.

APPENDIX A

PHOTOGRAPHIC FORMULAS

In laboratory procedures the results obtained depend on the use of the correct formula for a specific purpose. The procedures recommended in this formulary should be followed when normal results are desired. This formulary furnishes the data necessary for mixing and using the various solutions under normal working conditions. The necessary conversions must be made when greater or less amounts than those stated in the formula are required.

DEVELOPERS FOR FILMS OR PLATES

1. Pyro Metol

Stock solution A:

Water (about 100 °F)	64 oz
Metol	1 oz
Sodium bisulfite	1 oz
Pyro (crystals)	4 oz
Potassium bromide	240 grains
Cold water to make	1 gal

Stock solution B:

Water (100 °F)	1 gal
Sodium sulfite (desiccated)	1 lb, 4 oz

Stock solution C:

Water (120 °F)	1 gal
Sodium carbonate (desiccated)	10 oz

In mixing any formula, dissolve the chemicals in the order given. Do not add the next chemical until the previous one is dissolved, except when otherwise stated.

Tray development: One part each of stock solutions A, B, and C to eight parts of water. Develop 7 min at 68 °F. Discard after use.

Tank development: 1 part each of stock solutions A, B, and C to 13 parts of water. Develop 10 min at 68 °F. In tanks provided with floating covers this developer can be used for about 1 week if the volume is maintained by adding fresh stock solution in the proportion of one part each of stock solutions A, B, and C to four parts of water. Development time should be extended as the developer ages.

2. Very High-Contrast Developer

Water (90 °F)	96 oz
Sodium sulfite (desiccated)	12 oz
Hydroquinone	6 oz
Sodium hydroxide (caustic soda)	5 oz
Potassium bromide	4 oz
Cold water to make	1 gal

Dissolve chemicals as directed. Stir stock solution thoroughly before use. Use two parts of stock solution to one part of water. Develop in tray 2 min at 68 °F.

3. Medium- to High-Contrast Developer

Water	64 oz
Metol	60 grains
Sodium sulfite (desiccated)	10 oz
Hydroquinone	1 oz, 80 grains
Sodium carbonate (desiccated)	3 oz, 140 grains
Potassium bromide	292 grains
Cold water to make	1 gal

Dissolve chemicals as previously directed. For process-line negatives use without dilution. For copies of continuous-tone subjects dilute one part of stock solution to one part of water. Develop 5 min in tank or 4 min in tray at 68 °F.

4. Tropical Developer (75 to 90 °F)

Water (100 °F)	96 oz
Metol	328 grains
Sodium sulfite (desiccated)	6 oz
Cold water to make	1 gal

If crystalline sodium sulfite is used instead of desiccated, use 14 oz to the gallon in this formula. Dissolve chemicals as previously directed. Develop in tank 10 min at 68 °F or 2 to 3 min in fresh developer at 90 °F, according to contrast desired. When developing at a temperature below 75 °F, the sodium sulfite may be omitted if more rapid development is desired. The development time without the sulfite is 6 min at 68 °F. For tray development the time is about 20 percent less.

When development is completed, give the film only a brief rinse in water (2 sec) and then immerse it in a hardening bath (formula 16) for 3 min. Omit the water rinse if film appears to be softening. Fix at least 10 min in an acid hardening-fixing bath (formula 19 or 20), and wash 10 to 15 min in water. The temperature of the water should not exceed 95 °F. Note: Developers using Kodalk will not produce gas bells or blisters because it does not create a gas in the presence of acid. If a less contrast-producing developer is desired, reduce the amount of Kodalk in this formula to 295 grains/gal.

5. Rapid Developer - Type B (D-19)

Water (100 °F)	64 oz
Metol	128 grains
Sodium sulfite (desiccated)	12.5 oz, 140 grains
Hydroquinone	1 oz, 72 grains
Sodium carbonate (desiccated)	7 oz, 200 grains
Potassium bromide	292 grains
Cold water to make	1 gal

Dissolve chemicals as directed. Develop 6 min in a tank or 5 min in a tray at 68 °F.

5a. Replenisher for Formula 5 (D-19R)

Water (100 °F)	64 oz
Metol	256 grains
Sodium sulfite (desiccated)	12.5 oz, 140 grains
Hydroquinone	2 oz, 160 grains
Sodium carbonate (desiccated)	7 oz, 200 grains
Sodium hydroxide	1 oz
Cold water to make	1 gal

Dissolve chemicals as directed. Use without dilution. Add to the developer in the proportion of 1 oz for each 100 $in.^2$ of film processed. The maximum amount of replenisher added should not exceed the volume of the original developer.

6. Very Rapid Developer for Cut Films Only in Tray

Water (60 to 70 °F)	90 oz
Metol	1.75 oz, 30 grains
Sodium sulfite (desiccated)	10.5 oz
Hydroquinone	3.5 oz, 60 grains
Sodium hydroxide	3.5 oz, 60 grains

Add only enough water to dissolve the chemicals. This should make about 115 oz of developer solution. In this formula the sulfite will not dissolve until the sodium hydroxide is added. As considerable heat is produced, stand the mixing container in cold water. Use without dilution. Develop for 10 sec at 80 °F. Rinse for the same time and temperature as the development. For less contrast develop 8 sec. Immerse negative and agitate in fresh acid hardening-fixing bath at 80 °F until it clears. Rinse 10 sec and print wet.

7. Fine-Grain Developer (DK-20)

Water (100 °F)	96 oz
Metol	290 grains
Sodium sulfite (desiccated)	13.25 oz
Kodalk	116 grains
Sodium sulfocyanide (thiocyanide)	58 grains

Potassium bromide	29 grains
Cold water to make	1 gal

Dissolve as directed. Develop 15 min in tank or 11 min in tray at 68 °F. See recommendations for emulsion used.

8. Low-Contrast Developer (D-23)

Water (100 °F)	96 oz
Metol	1 oz
Sodium sulfite (desiccated)	13 oz, 140 grains
Cold water to make	1 gal

Dissolve chemicals as directed. Develop (on average) 19 min in tank or 15 min in tray at 68 °F. See emulsion recommendations.

9. Fine-Grain, Low-Contrast Developer for Roll Films, Sheet Films, and Plates (D-25)

Water (100 °F)	96 oz
Metol	1 oz
Sodium sulfite (desiccated)	13 oz, 140 grains
Sodium bisulfite	2 oz
Cold water to make	1 gal

Dissolve chemicals as directed. Develop 18 min in tank or 15 min in tray at 68 °F. This developer is nonstaining and nontoxic and compares favorably with the fine-grain paraphenylenediamine developers.

10. Normal-Contrast Developer for Sheet Film - Type C (DK-50)

Water (100 °F)	64 oz
Metol	145 grains
Sodium sulfite (desiccated)	4 oz
Hydroquinone	145 grains
Kodalk	1 oz, 145 grains
Potassium bromide	30 grains
Cold water to make	1 gal

Dissolve chemicals as directed. For tank development of portrait negatives dilute with an equal volume of water and develop 7 to 8 min at 68 °F. For tray development use without dilution and develop 3.5 to 4 min at 68 °F. For engineering negatives use without dilution and develop about 2 min in tank or 6 min in tray at 68 °F.

10a. Replenisher for Formula 10 (DK-50R)

Water (100 °F)	64 oz
Metol	300 grains
Sodium sulfite (desiccated)	4 oz
Hydroquinone	1 oz, 140 grains

Kodalk	5 oz, 145 grains
Potassium bromide	29 grains
Cold water to make	1 gal

Dissolve chemicals as directed. Add to the developer to maintain constant activity. If the developer is diluted 1-to-1, dilute the replenisher in the same proportion.

11. Low-Contrast Developer for Negatives (D-76)

Water (100 °F)	96 oz
Metol	116 grains
Sodium sulfite (desiccated)	13 oz, 140 grains
Hydroquinone	292 grains
Borax (granular)	116 grains
Cold water to make	1 gal

Dissolve chemicals as directed. Use without dilution. Develop approximately 17 min at 68 °F. See recommendations for material used.

11a. Replenisher for Formula 11 (D-76R)

Water (100 °F)	96 oz
Metol	176 grains
Sodium sulfite (desiccated)	13 oz, 140 grains
Hydroquinone	1 oz
Borax (granular)	2 oz, 280 grains
Cold water to make	1 gal

Dissolve chemicals as directed. Add replenisher without dilution to maintain activity of the developer solution. As with most replenishers the amount added is usually 0.75 oz for each 20 $in.^2$ processed.

12. High-Contrast Developer for Process Films (D-85)

Water (90 °F)	64 oz
Sodium sulfite (desiccated)	4 oz
Paraformaldehyde	1 oz
Sodium bisulfite	128 grains
Boric acid (crystals)[1]	1 oz
Hydroquinone	3 oz
Potassium bromide	90 grains
Water to make	1 gal

To mix, use a 1-gal bottle half filled with water. Add each chemical after the previous one is dissolved. While mixing, keep air out of the bottle as much as possible and agitate the solution thoroughly. When all chemicals have been dissolved, add cold water to make 1 gal. Air must be kept from this stock solution as much as possible. Allow the developer to stand about 2 hr before using.

[1]The crystal borax should be used because powdered borax is too difficult to dissolve.

Development time is 1.5 to 2 min at 68 °F. This developer cuts off development sharply in the low densities, thus ensuring clear dot formation in halftone negatives.

13. Developer for Papers - Type A (D-72)

Water (100 °F)	64 oz
Metol	180 grains
Sodium sulfite (desiccated)	6 oz
Hydroquinone	1.5 oz, 40 grains
Sodium carbonate (desiccated)	10 oz, 280 grains
Potassium bromide	108 grains
Cold water to make	1 gal

Dissolve chemicals as directed. For dilution and time of development see recommendations for materials used. This developer can also be used for films and plates (lantern slides).

STOP AND HARDENING BATHS

14. Stop Bath for Papers

Acetic acid,[2] 28 percent	0.5 oz
Water	32 oz

After development, rinse prints at least 5 sec in water. Prints should remain in stop bath 20 to 30 sec. Capacity: about twenty 8- by 10-in. prints per quart.

15. Hardening Bath for Films and Plates (65 to 75 °F)

Potassium chromium alum	1 oz
Water	32 oz

This bath is used in conjunction with fixing bath formula 22. Give films a brief water rinse after development; then immerse in hardening bath and agitate for about 20 sec. Films should remain in the bath 3 to 5 min to obtain maximum hardening. This bath should be frequently renewed because chromium alum loses its hardening properties. Renew at least daily.

16. Hardening Bath for Films and Plates (75 to 90 °F)

Water	32 oz
Potassium chromium alum	1 oz
Sodium sulfate (desiccated)[3]	2 oz

[2]Twenty-eight percent acetic acid is made by diluting three parts of glacial acetic acid with eight parts of water.

[3]If crystal sodium sulfate is used instead of desiccated, use 4.5 oz.

This bath is used in conjunction with developer formula 4. To prevent streaks, agitate the films for the first minute in the hardening bath. Films should remain in the bath at least 3 min before fixation. If the developer is cooler than 85 °F, rinse the water for 2 sec before immersing in the hardener bath.

When fresh this bath is violet-blue in tungsten light. When it turns to a yellow-green, it ceases to harden and should be replaced with a fresh bath. Unused, the bath will keep indefinitely, but the hardening capacity of a partly used bath decreases rapidly.

17. Hardening Bath for Use Prior to an Aftertreatment of Negatives

Water	32 oz
Formaldehyde (37 wt % of solution)	2.5 dr (10 cm^3)
Sodium carbonate (desiccated)	88 grains
Water to make	32 oz

This formula is recommended for treating negatives that are to receive a chemical treatment such as removal of stains, removal of water marks in drying, reduction, or intensification. Harden the films for 3 min in a fresh acid hardening-fixing bath. Wash thoroughly before applying any further chemical treatment.

18. Prehardener for Films Prior to High-Temperature Processing (80 to 110 °F)

Solution A:

Formaldehyde (37 wt % solution)	5 dr, 20 cm^3

Solution B:

Water	112 oz
0.5 Percent 6-nitrobenzimidazole nitrate[4]	
Sodium sulfite (desiccated)	6 oz, 280 grains
Sodium carbonate (desiccated)	1 oz, 260 grains
Water to make	1 gal

Prepare the working solution just before use by adding 1.25 dr of solution A to each 32 oz of solution B and mixing thoroughly. Immerse film in the prehardener for 10 min with moderate agitation. Then drain the film briefly and rinse in water for 30 sec. Drain thoroughly and immerse in the developer. Up to 90 °F, type B developer (D-19) or type D developer (D-76) may be used without modification. Development time will depend on the results desired. Approximate development times are listed below, with percentages based on the normal developing time recommended at 68 °F without prehardening:

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[4]Dissolve 18 grains in 8 oz of distilled water (1 g in 200 cm^3 water).

Temperature, °F	Development time, percent of normal
75	100
80	85
85	70
90	60
95	50

To control fog at temperatures above 95 °F, increase the amount of 6-nitrobenzimidazole nitrate up to double the amount given in the formula. Use a low-activity developer such as type D (D-76). Average developing time at 110 °F after prehardening is about one-quarter of the normal time at 68 °F. The useful life of the above prehardener is about forty 8- by 10-in. films per gallon.

FIXING BATHS

19. Acid Hardening-Fixing Bath

Water	96 oz
Sodium thiosulfate (hypo)	2 lb
Cold water to make	1 gal

If mixed by hydrometer, the reading should be 68 at 65 °F. Dissolve the hypo completely. When it is cool, add the following hardener stock solution slowly while stirring the hypo solution rapidly. The correct proportion is one part of hardener to six parts of hypo solution.

Water (125 °F)	56 oz
Sodium sulfite (desiccated)	8 oz
Acetic acid (28 percent)	24 fluid oz
Potassium alum	8 oz
Cold water to make	1 gal

Mix these chemicals in the order given. The sulfite must be dissolved completely before the acetic acid is added, and both must be mixed thoroughly before the alum is added.

20. Boric Acid Hardening Fixing Bath for Films, Plates, and Papers

Water (125 °F)	96 oz
Sodium thiosulfate (hypo)	2.5 lb
Cold water to make	1 gal

Prepare the following hardener stock solution:

Water (125 °F)	80 oz
Sodium sulfite (desiccated)	10 oz
Acetic acid (28 percent)	30 fluid oz

Boric acid (crystals)	5 oz
Potassium alum	10 oz
Cold water to make	1 gal

Dissolve chemicals in the order given. When the hypo is completely dissolved and both solutions are cool, add one part of the boric acid hardener to four parts of the hypo solution. Add slowly while stirring the hypo rapidly. A boric acid fixing bath gives much better hardening and has less tendency to precipitate a sludge of aluminum sulfite than does an ordinary acid fixing bath.

21. Rapid Fixing Bath for Negatives

Water (125 °F)	80 oz
Sodium thiosulfate (hypo)	3 lb
Ammonium chloride	6.75 oz
Sodium sulfite (desiccated)	2 oz
Acetic acid (28 percent)	6 fluid oz
Boric acid (crystals)	1 oz
Potassium alum	2 oz
Cold water to make	1 gal

Dissolve chemicals in the order given. Agitate the films in the bath and fix for twice the time the emulsion takes to clear. Fixing time should not be prolonged. This bath is not recommended for use with any paper emulsions. If corrosion occurs when using stainless steel containers, substitute 8 oz of ammonium sulfate for the 6.75 oz of ammonium chloride in this formula.

22. Chromium Alum Fixing Bath for Films

Solution A:

Sodium thiosulfate (hypo)	2 lb
Sodium sulfite (desiccated)	2 oz
Water (125 °F, or 52 °C) to make	96 oz

Solution B:

Water	32 oz
Potassium chromium alum	2 oz
Sulfuric acid	0.25 oz

Pour solution B into solution A slowly while stirring rapidly. This bath is recommended for hot-weather processing in conjunction with a chromium alum hardening bath (formula 15). This bath loses its hardening properties rapidly with or without use and should be frequently replaced. If a scum forms on the emulsion, it should be removed by swabbing before the film is dried.

23. Hypo Test Solution for Testing Thoroughness of Washing

Stock solution:

Distilled water	6 oz
Potassium permanganate	4 grains

Sodium hydroxide	8 grains
Distilled water to make	8 oz

Prepare the testing solution by taking 8 oz of pure water in a clear glass and adding 0.25 dr (about 15 drops) of the above stock solution. The solution should then be violet. Remove several of the films or prints to be tested from the wash water. Allow the water to drain from them into the testing solution for at least 30 sec. If hypo is present, the violet color of the solution will change to orange in about 10 to 30 sec. If much hypo is present, the orange will change to yellow and finally bleach completely. The material should be further washed until subsequent tests leave the violet color of the testing solution unchanged after it is allowed to stand about 2 min. This test will not be satisfactory if oxidizable organic matter is present in the wash water.

24. Hypo Eliminator

Water	64 oz
Hydrogen peroxide (3 percent solution)	16 oz
Ammonia (3 percent solution)	13 oz
Water to make	1 gal

Hypo may be eliminated and washing time saved by using this formula. Prepare the solution immediately before use. Do not keep the mixed solution in a closed container. Wash prints about 20 min at 65 to 70 °F, then immerse them for 6 min in the hypo eliminator solution at 68 °F. Keep the prints well separated. Wash for 10 min before drying; use longer washing time at lower temperatures. The useful life of the solution is about fifty 8- by 10-in. prints or equivalent per gallon.

To test for hypo, process a sheet of unexposed paper along with the prints. After the final wash, cut off a strip of this sheet and immerse it in a 1 percent solution of silver nitrate for 3 min. Rinse in water and compare, while wet, with the untreated wet portion. If the strip shows a yellow-brown tint, the presence of hypo is indicated. If hydrogen sulfide or wood extracts are present in the wash water, the test will also show positive and is not satisfactory.

Prints treated in this hypo eliminator may stick to the belt of the dryer. If this occurs, immerse prints for 3 min in a 1 percent formaldehyde solution. If the prints show a slight change in image tone, add 15 grains of potassium bromide to each quart of the eliminator solution. Prints treated in this hypo eliminator may show a faint yellowing in light areas. To correct this, immerse prints in a 1 percent solution of sodium sulfite for about 2 min immediately after treatment in the eliminator and before the final washing.

INTENSIFIERS AND REDUCERS

The following precautions should be taken to prevent stains in negatives during intensification or reduction processes:

(1) Thoroughly fix and wash the negatives, and be sure they are free from scum or stain.

(2) Harden the negatives in formalin hardener before treatment. See formula 17.

(3) Handle only one negative at a time, and agitate thoroughly during the treatment.

(4) If negatives are to be intensified or reduced, it is best to apply treatment immediately after they have been fixed and washed. Much time can thus be saved, and when dry the negatives are ready for printing.

25. Mercury Intensifier

Potassium bromide	0.75 oz
Mercuric chloride	0.75 oz
Water to make	32 oz

For maximum intensification bleach the negative until it is white and then wash thoroughly. Then redevelop or blacken the negative in a 10 percent solution of sodium sulfite by using a developer such as type A (D-72) diluted 1 to 2 or in a 10 percent ammonia solution (one part of 28 percent ammonia to nine parts of water). These solutions give progressively greater density. The 10 percent sulfite solution is usually recommended because it is simple to control and the intensification may be reduced or removed entirely by a brief rinsing in a fixing bath.

For greater contrast treat with the following solution:

Solution A:

Potassium cyanide[5]	0.50 oz
Water	16 oz

Solution B:

Silver nitrate (crystals)	0.75 oz
Water	16 oz

Add solution B to solution A until a precipitate is just produced. Allow to stand a short time and filter. Redevelopment with this formula cannot be controlled and must go to completion. This is known as Monckhoven's intensifier.

26. Chromium Intensifier

Stock solution:

Water	24 oz
Potassium bichromate	3 oz

[5]WARNING: Cyanide is a deadly poison and should be handled only with extreme care. Use rubber gloves and do not inhale the fumes. Use only in a well-ventilated room or outdoors. Be careful that the acid does not come into contract with the cyanide. Flush down the sink with plenty of water.

Hydrochloric acid	2 fluid oz
Water to make	32 oz

Take one part of stock solution to 10 parts of water. First harden the negative (formula 17). Then bleach the negative thoroughly at 65 to 70 °F. Wash 5 min in running water. Redevelop fully in artificial light or daylight (not sunlight) in any quick-acting, nonstaining developer that does not contain an excess of sodium sulfite. Type A developer (D-72) diluted 1 to 3 is recommended. Develop about 10 min at 68 °F.

Greater intensification can be obtained by repeating the process, although little is gained by more than one repetition. Negatives intensified by this formula are more permanent than those intensified with mercuric chloride.

27. Silver Intensifier

Stock solution A (keep in a brown bottle):

Silver nitrate (crystals)	2 oz
Distilled water to make	32 oz

Stock solution B:

Sodium sulfite (desiccated)	2 oz
Water to make	32 oz

Stock solution C:

Sodium thiosulfate (hypo)	3.5 oz
Water to make	32 oz

Stock solution D:

Sodium sulfite (desiccated)	0.50 oz
Metol	350 grains
Water to make	96 oz

This formula gives proportional intensification and is easily controlled by varying the treatment time. It will not change the color of positive film to be used for projection and is equally suitable for positive and negative film.

To prepare the working intensifier, slowly add one part of solution B to one part of solution A. Thoroughly mix and then add one part of solution C. Allow the solution to stand until clear and add, while stirring, three parts of solution D. Use immediately because the mixed solution is stable for only about 30 min at 68 °F. The degree of intensification obtained depends on the treatment time, which should not exceed 25 min. After intensification immerse the film for 2 min in a plain 30 percent hypo solution (2.5 lb/gal). Then wash thoroughly. For best results this intensifier should be used in artificial light.

28. Redevelopment Intensifier

Negatives can be intensified simply by bleaching in the ferricyanide-bromide formula used for sepia toning and then redeveloping with sodium sulfide as in print toning. See formula 37.

29. Subtractive or Cutting Reducer (Farmer's Reducer)

Stock solution A:

Potassium ferricyanide	1.25 oz
Water to make	16 oz

Stock solution B:

Sodium thiosulfate (hypo)	16 oz
Water to make	64 oz

Take 1 oz of solution A and 4 oz of solution B and mix in water to make 32 oz. Immerse the negative in the solution and agitate continuously. Watch progress closely as reduction gains in speed. Just before the desired degree of reduction immerse the negative in water and thoroughly wash before drying. For less rapid reduction use 0.50 oz of solution A to the same quantity of solution B and water. Do not mix these stock solutions until they are to be used because the mixed solution deteriorates rapidly. Use in artificial light. Used as a single solution this reducer gives only subtractive reduction, which corrects overexposure.

30. Two-Solution Farmer's Reducer

Solution A:

Potassium ferricyanide	0.25 oz
Water to make	32 oz

Solution B:

Sodium thiosulfate (hypo)	6.75 oz
Water to make	32 oz

More proportional reduction is obtained when Farmer's reducer is used in separate solutions. Place the negative in solution A and agitate for 1 to 4 min at 65 °F, depending on the degree of reduction desired. Then immerse in solution B for 5 min. Wash thoroughly. The process may be repeated if more reduction is desired.

31. Proportional Reducer - to Lower Contrast

Stock solution A:

Potassium permanganate	4 grains

Sulfuric acid (10 percent solution)[6]	0.50 fluid oz
Water to make	32 oz

Stock solution B:

Potassium persulfate[7]	3 oz
Water to make	96 oz

Use one part of solution A to three parts of solution B. Agitate the negative continuously in the solution. After reduction clear the negative in a 1 percent solution of sodium bisulfite. Wash thoroughly before drying.

32. Superproportional Reducer - for Great Reduction of Highlight Density (Contrast)

Stock solution A:

Potassium persulfate	1 oz
Water to make	32 oz

Stock solution B:

Water	8 oz
Sulfuric acid (10 percent solution)	0.50 oz
Water to make	16 oz

Use two parts of solution A and one part of solution B. Only glass, hard rubber, or unchipped enamel ware should be used for the solution during mixing and use. Harden the negative for 3 min (in formula 17) before reduction. Agitate the negative continuously while it is in the solution. Reduce by inspection because control by time is not possible. When the desired reduction is almost attained, rinse the negative briefly in water and then immerse it in an acid fixing bath for 5 min. Wash thoroughly before drying. Discard the used solution.

STAIN REMOVERS

33. Tray Cleaner

Potassium bichromate	3 oz
Sulfuric acid	3 oz
Water to make	32 oz

Dissolve the bichromate and then add the acid slowly to the water. Pour a small amount into the tray and rinse around so that the cleaner reaches all parts of the tray. After cleaning rinse tray in six to eight changes of water until all trace of the cleaning solution has disappeared. Do not use this solution for cleaning enamel trays, as it gradually affects the enamel and makes it rough.

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[6] To make 10 percent sulfuric acid, add one part of acid to nine parts of water.

[7] Ammonium persulfate may be used in the same proportion.

Note: Trays should be cleaned with a little fixing bath solution immediately after use and not allowed to become contaminated in such manner that the above cleaner will be necessary.

34. Formula to Remove Stains on Hands

Solution A:[8]

Potassium permanganate	0.25 oz
Sulfuric acid	0.50 oz
Water to make	1 gal

Solution B:

Water	96 oz
Sodium bisulfite	4 oz
Sulfuric sulfite (desiccated)	4 oz
Water to make	1 gal

Remove any rings from your fingers and immerse your hands for 1 to 3 min in solution A. Rinse them briefly in water and immerse for a few minutes in solution B; then wash them thoroughly with soap and warm water.

35. Formula to Remove Developer Stains on Negatives

Stock solution A:

Potassium permanganate	75 grains
Water to make	32 oz

Stock solution B:

Cold water	16 oz
Sodium chloride (salt)	2.5 oz
Sulfuric acid	0.50 oz
Water to make	32 oz

These formulas are used for removing developer stain from negatives. Harden the negative in formalin hardener (formula 17) and then wash 5 min. Prepare the following solutions: Use equal parts of solutions A and B. Mix only for immediate use. Be sure that all permanganate grains are dissolved before using the solution. Bleach the negative for 3 to 4 min at 68 °F. To remove brown stains, immerse the negative in a 1 percent solution of sodium bisulfite. Rinse the negative and redevelop it in a strong light, using type A developer (D-72) diluted 1 to 2. Then wash thoroughly. Do not use a slow-working developer, such as type D (D-76) since this type of developer tends to dissolve the bleached image before the developing agents have time to act.

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[8]Store this solution in a stoppered glass bottle away from light.

Removal of Water Marks from Negatives

Negatives may show irregular marks caused by water drops remaining on the emulsion after the surrounding areas are dry. These spots can be eliminated by treating the film in a 10 percent solution of sodium carbonate at 60 °F. First harden the emulsion according to formula 17. Rinse the film in cold water for about 1 min and then immerse it in the carbonate solution for 1 to 5 min. In this time the water marks should disappear. The time in the carbonate solution should not exceed 5 min.

PRINT TONING

The quality of the results obtained with the following toning formulas depends on the degree of development the print has received. Unless the exposed silver halides have been fully reduced by developing the print for the full time specified in the formula, the results produced in the toning process will be of inferior quality.

36. Sepia Toner

Water	96 oz
Polysulfide (liver of sulfur)	1 oz
Sodium carbonate (desiccated)	140 grains
Water to make	1 gal

Prints must be thoroughly washed. Immerse the print and agitate it for 15 to 20 min at 68 °F. If the bath is heated to 100 °F, the toning time will be shortened to 3 or 4 min. After toning swab the surface of the print with a soft sponge or cotton and then wash it for at least 30 min before drying.

37. Sulfide Toner for Warm Sepia Tones

Solution A:

Potassium ferricyanide	1 oz
Potassium bromide	0.50 oz
Water to make	32 oz

Solution B:

Sodium sulfide (not sulfite)[9]	13 grains
Water to make	32 oz

Thoroughly wash the print and then immerse it in solution A until it is completely bleached. Wash for 5 min and immerse in solution B for about 2 min, or until the image is fully toned. The toning or redevelopment should not be prolonged more than is necessary to completely tone the image. Wash thoroughly for

[9] Use three times the quantity if crystalline sulfide is used. Crystalline sodium sulfide is somewhat unstable and tends to liquefy. Use only the crystals when compounding this formula.

about 15 min before drying. This toner may also be used for lantern slides. In the latter case, transparency will be much improved by adding 66 grains of sodium thiosulfate (hypo) to 32 oz of solution B.[10]

38. Hypo-Alum Sepia Toner

Cold water	90 oz
Sodium thiosulfate (hypo)	16 oz

When completely dissolved add:

Hot water (160 °F)	20 oz
Potassium alum	4 oz

Then add slowly the following, including precipitate, to the above combined solutions, while stirring rapidly:

Cold water	2 oz
Silver nitrate (crystals)	60 grains
Sodium chloride (salt)	60 grains
Water to make a combined solution of	1 gal

Dissolve each chemical completely before adding the next. Heat the solution in a water bath to 120 °F. The prints should tone in 12 to 15 min. Do not use solution above 120 °F. Black-and-white prints should be slightly darker than normal when toned in this solution and thoroughly fixed and washed. Soak dry prints in water before toning. To secure even toning, immerse prints completely in the warm solution and separate them during the first few minutes. Swab prints after toning and then wash for 1 hr in running water.

39. Gold Toner for Sepia or Intermediate Tones

Stock solution A:

Warm water	1 gal
Sodium thiosulfate (hypo)	2 lb
Potassium or ammonium persulfate	4 oz

Dissolve the hypo completely and add the persulfate while stirring rapidly. If necessary raise the temperature until the bath turns milky. Cool the bath, and add the following while stirring the hypopersulfate rapidly:

Cold water	2 oz
Silver nitrate (crystals)	75 grains
Sodium chloride	75 grains

Dissolve the silver nitrate completely before adding the sodium chloride.

---

[10]CAUTION: Do not use sodium sulfide near films or papers because the fumes tend to produce fog in all sensitized materials.

Stock solution B:

Water	8 oz
Gold chloride	15 grains

Add 4 oz of solution B to solution A while stirring rapidly. Allow the bath to become cold and then pour off the clear solution for use. Prints should be washed for a few minutes after fixing and before toning. Soak dry prints thoroughly in water before toning. Heat the solution to 110 °F and, while toning, maintain the temperature between 100 and 110 °F by using a water bath. Keep prints separated during the entire process to ensure even toning. After toning to the degree desired, rinse the prints in cold water. Return them to the fixing bath for 5 min and then wash for 1 hr in running water.

40. Iron Toner for Blue Tones

Ferric ammonium citrate (green scales)	58 grains
Oxalic acid (crystals)	58 grains
Potassium ferricyanide	58 grains
Water to make	32 oz

Dissolve each chemical separately in about 8 oz of water and filter before mixing. Keep the solution in a brown bottle. Prints must be well washed and immersed in the toning bath for 10 to 15 min - until the desired tone is obtained. After toning wash the prints until the highlights are clear.

APPENDIX B

TABLES OF WEIGHTS AND MEASURES

LINEAR MEASURE
United States Customary

12 inches (in.) = 1 foot (ft)
3 feet = 1 yard (yd)
5-1/2 yards = 1 rod
16-1/2 feet = 1 rod
320 rods = 1 statute mile
5280 feet = 1 statute mile
6080 feet = 1 nautical mile (n mi)
3 nautical miles = 1 nautical league

SQUARE MEASURE
United States Customary

144 square inch (sq in) = 1 square foot (sq ft)
9 square feet = 1 square yard (sq yd)
30-1/4 square yards = 1 square rod
160 square rods = 1 acre
640 acres = 1 square mile (sq mi)

CUBIC MEASURE
United States Customary

1728 cubic inches (cu in) = 1 cubic foot (cu ft)
27 cubic feet = 1 cubic yard (cu yd)
128 cubic feet = 1 cord
16-1/2-25 cubic feet = 1 perch

LIQUID MEASURE
United States Customary

4 gills = 1 pint (pt)
2 pints = 1 quart (qt)
4 quarts = 1 gallon (gal)
31-1/2 gallons = 1 barrel (bbl)
2 barrels = 1 hogshead

DRY MEASURE
United States Customary

2 pints (pt) = 1 quart (qt)
8 quarts = 1 peck (pk)
4 pecks = 1 bushel (bu)

METRIC CONVERSION TABLE

1 meter = 39.37 inches = 3.28083 feet = 1.0936 yards
1 centimeter = 0.3937 inch
1 millimeter = 0.03937 inch = 1/25 inch (approximately)
1 kilometer = 0.62137 mile
1 foot = 0.3048 meter (m)

AVOIRDUPOIS WEIGHT

27.3438 grains = 1 dram (dr)
16 drams = 1 ounce (oz)
7000 grains = 1 pound (lb)
16 ounces = 1 pound (lb)
100 pounds = 1 hundredweight
20 hundredweight = 1 ton
2000 pounds = 1 ton

APOTHECARIES WEIGHT

20 grains = 1 scruple (sc)
3 scruples = 1 dram (dr)
8 drams = 1 ounce (oz)
12 ounces = 1 pound (lb)

METRIC WEIGHT

10 milligrams (mg) = 1 centigram (cg)
10 centigrams = 1 decigram (dg)
10 decigrams = 1 gram (g)
10 grams = 1 dekagram (dag)
10 decagrams = 1 hectogram (hg)
10 hectograms = 1 kilogram (kg)
1000 kilograms = 1 metric ton

APPENDIX C

CONVERSION FACTORS

PHOTO DISTANCES

1 inch = 25.4 millimeters (mm)
0.001 inch = 0.0254 millimeter
0.001 inch = 25.4 micrometers (μm)
1 millimeter = 1000 micrometers
1 centimeter = 10 millimeters
1 meter = 1000 millimeters

GROUND DISTANCES

1 military pace = 2.5 feet
1 meter = 3.281 feet
1 kilometer = 0.6214 mile
1 mile = 5280 feet
1 nautical mile = 6080 feet
1 mile = 8 furlongs
1 furlong = 10 chains
1 chain = 4 rods
1 rod = 16.5 feet

GROUND AREAS

1 acre = 43 560 square feet
1 square mile = 640 acres
1 square mile = 27 878 400 square feet
1 square mile = 2.590 square kilometers (sq km)
1 square mile = 259 hectares

ANGULAR MEASURES

60 seconds = 1 minute (min)
60 minutes = 1 degree (deg)
360 degrees = 400 grads
1 grad = 0.9 degrees
1 grad = 54 minutes
1 centesimal minute = 100 centesimal seconds (sec)

MISCELLANEOUS

1 cubic foot = 7.481 gallons (gal)
1 kilogram = 2.205 pounds
1 fathom = 6 ft
1 mile per hour = 1.467 feet per second
1 knot = 1.689 feet per second
Degrees Centigrade = 5/9 (Degrees Fahrenheit - 32)
Degrees Fahrenheit = 9/5 (Degrees Centigrade + 32)

APPENDIX D

INTERNATIONAL ATOMIC WEIGHTS

Elements	Symbol	Atomic weight	Elements	Symbol	Atomic Weight
Aluminum	Al	27.1	Neodymium	Nd	144.3
Antimony	Sb	120.2	Neon	Ne	20.2
Argon	A	39.9	Nickel	Ni	58.68
Arsenic	As	74.96	Niton (radium emanation)	Nt	222.4
Barium	Ba	137.37			
Bismuth	Bi	208.0	Nitrogen	N	14.008
Boron	B	10.9	Osmium	Os	190.9
Bromine	Br	79.92	Oxygen	O	16.00
Cadmium	Cd	112.40	Palladium	Pd	100.5
Calcium	Ca	40.07	Phosphorus	P	31.04
Carbon	C	12.005	Platinum	Pt	195.2
Cerium	Ce	140.25	Potassium	K	39.10
Cesium	Cs	132.81	Praseodymium	Pr	140.9
Chlorine	Cl	35.46	Radium	Ra	226.0
Chromium	Cr	52.0	Rhodium	Rh	102.9
Cobalt	Co	58.97	Rubidium	Rb	85.45
Columbium	Cb	93.19	Ruthenium	Ru	101.7
Copper	Cu	63.57	Samarium	Sa	150.4
Dysprosium	Dy	162.5	Scandium	Sc	45.1
Erbium	Er	167.7	Selenium	Se	79.2
Europium	Eu	152.0	Silicon	Si	28.3
Fluorine	F	19.0	Silver	Ag	107.88
Gadolium	Gd	157.3	Sodium	Na	23.00
Gallium	Ga	70.1	Strontium	Sr	87.63
Germanium	Ge	72.5	Sulfur	S	32.06
Glucinum	Gl	9.1	Tantalum	Ta	181.5
Gold	Au	197.2	Tellurium	Te	127.5
Helium	He	4.00	Terbium	Tb	159.2
Holmium	Ho	163.5	Thallium	Tl	204.0
Hydrogen	H	1.008	Thorium	Th	232.15
Indium	In	114.8	Thulium	Tm	168.5
Iodine	I	126.2	Tin	Sn	118.7
Iridium	Ir	193.1	Titanium	Ti	48.1
Iron	Fe	55.84	Tungsten	W	184.0
Krypton	Kr	82.92	Uranium	U	238.2
Lanthanum	La	139.0	Vanadium	V	51.0
Lead	Pb	207.20	Xenon	Xe	130.2
Lithium	Li	6.94	Ytterbium (neoytterbium)	Yb	173.5
Lutecium	Lu	175.0			
Magnesium	Mg	24.32	Yttrium	Yt	89.33
Manganese	Ma	53.93	Zinc	Zn	65.37
Mercury	Hg	200.6	Zirconium	Zr	90.6
Molybdenum	Mo	96.0			

APPENDIX E

COMPARISON OF FILM SPEED RATING SYSTEMS

This table is only a general guide. Mathematical conversion of these systems is impractical since the systems have no common basis. This table will furnish a good working basis when film-speed conversions become necessary.

ASA exposure index	General electric	Weston	American Schiener, deg	European Schiener, deg	Din, deg	Relative exposure required
0.6	0.6	0.5	6	12	-----	106.66
.8	------	.6	7	13	-----	80.00
1.0	1.0	.7	8	14	1/10	64.00
1.2	1.5	1.0	9	15	2/10	53.33
1.6	2.0	1.2	10	16	3/10	40.00
2.0	------	1.5	11	17	4/10	32.00
2.5	3	2.0	12	18	5/10	25.60
3	4	2.5	13	19	6/10	21.33
4	------	3	14	20	7/10	16.00
5	6	4	15	21	8/10	12.80
6	8	5	16	22	9/10	10.67
8	10	6	17	23	10/10	8.00
10	12	8	18	24	11/10	6.40
12	16	10	19	25	12/10	5.33
16	20	12	20	26	13/10	4.00
20	24	16	21	27	14/10	3.20
25	32	20	22	28	15/10	2.56
32	40	24	23	29	16/10	2.00
40	48	32	24	30	17/10	1.60
50	64	40	25	31	18/10	1.28
64	80	50	26	32	19/10	1.00
80	100	64	27	33	20/10	.80
100	125	80	28	34	21/10	.64
125	150	100	29	35	22/10	.50
160	200	125	30	36	23/10	.40
200	250	160	31	37	24/10	.32
250	300	200	32	38	25/10	.25
320	400	250	33	39	26/10	.20
400	500	320	34	40	27/10	.16
500	600	400	35	41	28/10	.13
650	800	500	36	42	29/10	.10
800	900	650	37	43	30/10	.08
1000	1000	800	38	44	31/10	.06

APPENDIX F

TABLE OF SAFELIGHT FILTERS

Wratten number	Color	Used when processing-
OA	Green-yellow	Bromide and chloride papers
1	Red	Orthochromatic films
2	Dark red	High-speed orthochromatic film
3	Dark green	Panchromatic film
6B	Amber	X-ray or dental films. Not recommended for any other photographic films.
7	Light green	Infrared films and Kodak Ektacolor print film
8	Dark yellow	Kodak color print film, type 5381
OC	Light amber	Variable-contrast papers
DuPont S55X	Orange-brown	Variable-contrast papers

APPENDIX G

ELECTROMOTIVE SERIES OF METALS

K, Na, Ca	These metals react with cold water to produce hydrogen gas and metal hydroxides, and they react violently with acids.
Mg, Al, Mn, Zn, Cr, Fe	These metals react with steam to produce metal oxides and hydrogen gas.
Co, Ni, Sn, Pb	These metals react with dilute nonoxidizing acids at room temperature to form hydrogen gas.
Hydrogen	
Cu, As, Bi, Sb, Hg, Pt, Au	These metals do not react with water or dilute acids to yield hydrogen gas.

APPENDIX H

GLOSSARY OF TERMS

Aberrations	Optical defects in a lens that cause imperfect images
Abrasions	Marks on emulsion surfaces that appear as pencil marks or scratches; usually caused by pressure or rubbing
Accelerator	The alkali added to a developing solution to increase the activity of a developing agent and to swell the gelatin, thus shortening developing time
Acetate base	The term used to designate a photographic film base composed of cellulose acetate; also referred to as safety base because of its nonflammability
Acetic acid ($HC_2H_3O_2$)	The acid widely used in short-stop baths to stop the action of the developer before negatives or prints are placed in the fixing bath; often used in fixing baths
Achromatic lens	A lens that is at least partially corrected for chromatic aberration
Acid fixing bath	A solution of hypo to which has been added an acid (usually acetic acid) for the purpose of maintaining the hypo at the proper acidity
Actinic light	Light that can cause photochemical changes in a sensitive emulsion. Blue and violet are the most actinic of the visible light rays
Additive process	Pertains to color photography; the production of color by the superposition of the separate primary-colored lights on the same screen. Yellow, for example, is a mixture of red and green light rays in the proper proportion.
Adurol	A form of hydroquinone that is used as a developing agent; chemical name is monobromohydroquinone
Affinity	The chemical attraction of one substance for another. Sodium sulfite has an affinity for oxygen, thereby reducing oxidation of the developing agent in a developer.
Agitation	The procedure used in processing to bring fresh solution in contact with the emulsion. This may be done by moving the material in the solution, as in tank development, or by moving the solution

	itself, as in tray development. Agitation may be either constant or intermittent. Agitation is necessary to ensure uniform development results.
Air bells	Small bubbles of air that attach to the surface of an emulsion and leave a small area unaffected by the solution; can be removed by vigorous agitation
Alkali	A substance with basic properties that can neutralize acid. An alkali commonly used in developing solutions is sodium carbonate. Alkalies are often referred to as "accelerators or activators."
Anastigmat	A lens that has been corrected for astigmatism and therefore focuses vertical and horizontal lines with equal brightness and definition. Anastigmat lenses are also free from other common aberrations.
Angle of view	The angle subtended at the lens center by the ends of the film or plate diagonal
Angstrom unit (AU)	A unit of length equal to one ten-thousandth of a micrometer; commonly used as a method of expressing the length of light rays
Anhydrous	refers to chemical salts that contain no water of crystallization; identical in meaning with "desiccated"
Aniline (anilin)	A coal tar derivative used as a basis for many dyes; can also be produced by the reduction of nitrobenzene
Ansco color	An integral, tripack natural-color film that can be activity processed
Antihalation backing	A coating, usually gelatin, on the back of a film, containing a dye or pigment for absorbing light rays and thus preventing reflection from the back surface of the film base
Aperture	A small opening, usually circular. In cameras the aperture is usually variable, in the form of an iris diaphragm, and regulates the intensity of light that passes through a lens.
Apochromatic	Refers to lenses that are most completely corrected for chromatic aberration. These lenses focus rays of all colors to very nearly the same plane.

Astigmatism	A lens aberration in which both the horizontal and vertical lines in the edge of the field cannot be accurately focused at the same time
Axis of lens	An imaginary line passing through the center of a lens and containing the centers of curvature of the lens surfaces
Barrel distortion	A term applied to the barrel-shaped image of a square object obtained when the diaphragm is placed in front of a simple convex lens
Baryta	A treated emulsion of barium sulfate. It is commonly used in the manufacture of photographic paper to coat the paper stock before the light-sensitive emulsion is coated. It provides a white surface and keeps the light-sensitive emulsion from being partially absorbed by the paper base.
Blisters	Small bubbles forming under an emulsion due to the detachment of the emulsion from its base. Blisters are caused by some fault in the processing.
Blowup	Photographic slang for enlargement
Brightness range	Variation of light intensities from maximum to minimum, generally referring to a subject to be photographed. For example, a particular subject may have a range of 1 to 4; that is, four times the amount of light is reflected from the brightest highlights as from the least bright portion of the subject.
Brilliance	A term denoting the degree of intensity of a color or colors
Bromide paper	A photographic printing paper in which the emulsion is made sensitive largely through silver bromide. Bromides papers are relatively fast and usually printed by projection.
Bulb	A camera exposure setting that allows the shutter to remain open as long as the shutter release mechanism is depressed
Cable release	A flexible shaft for operating the camera shutter
Camera obscura	A darkened room in which an image is formed on one wall by light entering a small hole in the opposite wall

Carbonates	A term applied to certain alkaline salts, such as potassium carbonate and sodium carbonate, used as an accelerator in a developer
Catch lights	The small reflections of a light source found in the eyes of a portrait subject
Cellulose acetate	See "Acetate base."
Cellulose nitrate	See "Nitrate base."
Changing bag	A light-proof bag equipped with openings for the hands, in which films can be loaded or unloaded in daylight
Characteristic curve	A curve plotted to show the relation of density to exposure; sometimes referred to as the H&D curve
Chloride paper	A photographic printing paper in which the emulsion is made sensitive largely through silver chloride. Usually chloride papers are printed by contact and require comparatively longer exposure than bromide or chlorobromide paper.
Chlorobromide paper	A photographic printing paper used basically for enlarging. Its emulsion contains a mixture of silver chloride and silver bromide.
Chromatic aberration	A defect in a lens that prevents it from focusing different-colored light rays in the same place
Circle of confusion	An optical term describing the size of an image point formed by a lens
Clumping	The effective increase in grain size in the emulsion due to the partial overlapping of grains of silver
Color	The sensation produced in the eye by a particular wavelength or group of wavelengths of visible light
Color sensitivity	The response of a photographic emulsion to light of various wavelengths
Comma	A lens aberration in which a comma- or pear-shaped image is formed by oblique rays from an object point removed from the principal axis of the lens.
Complementary colors	A color is complementary to another when a combination of the two produce white light.
Composition	The balancing of shapes and tones to produce a pleasing effect

Condenser	An optical system in projection printers used to collect the divergent rays of a light source and concentrate them upon the objective lens.
Contact print	A print made by placing a sensitive emulsion in direct contact with a negative and passing light through the negative.
Contrast	Subject contrast is the difference between the reflective abilities of various areas of a subject. Lighting contrast is the difference in intensities of light falling on various parts of a subject. Inherent emulsion contrast is the possible difference between the maximum and minimum densities of the silver deposits with a minimum variation of exposure. It is determined by the manufacturer. Development contrast is the gamma to which an emulsion is developed. It is controlled only the developer, time, temperature, and agitation.
Convertible lens	A lens containing two or more elements that can be used individually or in combination to give a variety of focal lengths
Covering power	The capacity of a lens to give a sharply defined image to the edges of the sensitized material it is designed to cover at the largest possible aperture
Crop	To trim or cut away the unnecessary portions of a print to improve composition
Curtain aperture	The slit in a focal plane shutter that permits the light to reach the film. The slit size may be either fixed or variable.
Curvature of field	The saucer-shaped image of a flat object formed by an uncorrected lens
Cut film	A flexible transparent base coated with a sensitized emulsion and cut in sheets of various sizes; often referred to as sheet film
Cyan	A blue-green (minus red) color
Darkroom	A room for photographic operations, mainly processing, that can be made free from white light and is usually equipped with safelights emitting nonactinic light
Definition	See "Resolving power."

Delayed action	Another term for a self-timer - a device on the shutter of the camera that permits the shutter to trip about 10 sec after it is released
Deliquescence	The property by which a chemical salt absorbs moisture directly from the atmosphere
Densitometer	A device for measuring the density of a silver deposit in a photographic image. It is usually limited to measuring even densities in small areas.
Density	A term used in expressing the light-stopping power of a blackened silver deposit in relation to the light incident upon it
Depth of field	The distance measured between the nearest and farthest planes in the subject area that give satisfactory definition
Depth of focus	The distance that a camera back can be racked back and forth while preserving satisfactory image detail in the focal plane for a given object point
Desensitizer	An agent, usually a chemical solution, for decreasing the color sensitivity of a photographic emulsion to facilitate developing under a comparatively bright light. The emulsion is desensitized after exposure.
Desiccated	A term applied to chemicals in which all moisture has been eliminated
Developer	A solution used to make visible the latent image in an exposed emulsion
Developing agent	A chemical compound possessing the ability to change exposed silver halide to black metallic silver, while leaving the unexposed halide unaffected
Developing-out paper	A printing paper in which the image is made visible by developing in a chemical solution
Diaphragm	A device for controlling the amount of light that passes through a lens. It is usually an iris diaphragm but may be in the form of slotted disks of fixed sizes.
Dichroic fog	A two-color stain observed in film or plates that appears green by reflected light and pink by transmitted light

Diffraction	An optical term used to denote the spreading of a light ray after it passes the edge of an obstacle
Diffusion	The scattering of light rays from a rough surface, or the transmission of light through a translucent medium
Din	A European system of measuring film speed; little used in this country
Dispersion	The separation of light into its component colors by passing white light through a prism
Distortion	Defects caused by uncorrected lenses, resulting in images that are not the proper shape
Dodging	The process of holding back light from certain areas of sensitized material to avoid over-exposure of these areas
Double exposure	The intentional or unintentional recording of two separate images on a single piece of sensitized material
Double extension	A term used to describe the position of a camera bellows. A double-extension bellows has an extended length of about twice the focal length of the lens being used.
Dry mounting	A method of cementing a print to a mount by means of a thin tissue of thermoplastic material. The tissue is placed between the print and the mount, and sufficient heat is applied to melt the tissue.
Easel	A device to hold sensitized paper in a flat plane on an enlarger; generally includes an adjustable mask to accommodate different sizes of paper
Efflorescence	The process by which a chemical salt loses it water of crystallization upon exposure to air
Embossing	The process by which the central portion of a print is depressed, leaving a raised margin
Emulsion	The light sensitive layer, consisting of silver salts suspended in gelatin, that is spread over a permanent support such as film, glass, or paper
Emulsion speed	The factor that determines the exposure necessary to produce a satisfactory image; commonly expressed in Weston, General Electric, or ASA emulsion numbers assigned to the film

Enlargement	A print made from a negative or positive by projecting an enlarged image on sensitized material
Exposure	The product of time and intensity of illumination acting on the photographic material
Exposure meter	An instrument for measuring light intensity and determining correct exposure
f number	A system of denoting lens apertures
Fading	The gradual elimination, usually of the print image, from the action of light or other oxidation
Farmer's reducer	A formula composed of potassium ferricyanide and hypo used to reduce either negative or print densities
Ferrotype plates (tins)	Sheets of thin enameled or chromium-plated metal used in obtaining high gloss on prints. Some plates are made of polished stainless steel.
Film	A sheet or strip of celluloid coated with a light-sensitive emulsion for exposure in a camera. This celluloid support has either a nitrate or on acetate base.
Filter (light or color)	A piece of colored glass or gelatin that is usually placed in front of the camera lens to compensate for the difference in color sensitivity between the film and the eye; also used to modify or exaggerate contrast and to provide primary color separation in color photography
Filter factor	The number by which the correct exposure without the filter must be multiplied to obtain the same effective exposure with the filter
Fixation	The process of making soluble the undeveloped silver salts in a sensitized material by immersion in a hypo solution
Fixed focus	A term applied to a camera in which the lens is set permanently in such a position as to give good average focus for both nearby and distant objects
Flat	The expression denoting lack of contrast in a print or negative
Flatness of field	The quality of a lens that produces sharpness of image both at the edges and at the center of the negative.

Focal length	The distance between the center of the lens and the point at which the image of a distant object comes into critical focus
Focal plane	The plane at which the image is brought to a critical focus; in other words, the position in the camera occupied by the film emulsion
Focal plane shutter	A shutter that operates immediately in front of the focal plane. A shutter of this type usually contains a fixed- or variable-sized slit in a curtain of cloth or metal that travels across the film to make the exposure.
Focus	The plane toward which the rays of light converge to form an image after passing through a lens
Focusing scale	See "Vernier scale."
Focusing screen	A sheet of ground glass on which the image is focused
Fog	A veil or haze over the negative or print from undesired chemical action or light
Foot-candle	The intensity of light falling on a surface placed 1 foot distant from a point light source of 1 candle power
Frilling	The detachment of the emulsion from its support around the edges; happens most often in hot weather or because of too much alkali in the developer
Gamma	A numerical measure of the contrast to which an emulsion is developed
Gamma infinity	The maximum contrast to which an emulsion can be developed
Gas bells	Bubbles forcing the emulsions from the support, caused by strong chemical action and resulting in minute holes in the negative
Gelatin	A jelly-like byproduct produced from bones, hoofs, horns, and other animal parts
Gradation	The range of densities in an emulsion from highlights to shadows
Grain	Individual silver particles or groups of particles in the emulsion that, when enlarged, become noticeable and objectionable

Grain	A unit of weight. In the avoirdupois system 437.5 grains equals an ounce.
Gray scale	See "Sensitometric strip."
Halation	A blurred effect, resembling a halo, usually occurring around bright objects; caused by the reflections of rays of light from the back of the negative material
Halftones	The middle tones lying between the shadows and the highlights
Halides (or haloids)	A chemical term applied to binary compounds containing any of the elements chlorine, bromine, iodine, and fluorine
Halogen	Iodine, fluorine, chlorine, and bromine are known as halogens.
Hard	A term used to denote excessive contrast
Hardener	A chemical such as potassium alum or chromium alum that is added to the fixing bath to harden the gelatin after development. Prehardening solutions may be used before development.
H&D (Hurter and Driffield) system	A system for measuring film speed; little used in this country
Highlights	The brightest parts of the subject; represented by the denser parts of the negative and the light gray and white tones of the print
Hydrometer	An instrument used to find the concentration of a single chemical in water; most common use is in mixing large quantities of hypo
Hydroquinone	A reducing agent that is widely used in compounding developers for photographic materials
Hyperfocal distance	The distance from the lens to the nearest plane in sharp focus when the lens is focused at infinity distance
Hypo	A contraction of sodium hyposulfite (sodium thiosulfate); used in compounding fixing solutions, which in turn, are used to make soluble the undeveloped silver salts in an emulsion.
Imbibition	Literally the act of absorbing; the process of dye transfer in the washoff relief process of making color prints

Incandescent	Glowing with heat, such as the tungsten filament in an incandescent lamp
Infinity	A distance so far removed from an observer that the rays of light reflected to a lens from a point at that distance may be regarded as parallel; a distance setting on a camera focusing scale beyond which all objects are in focus
Infrared	Invisible rays of light beyond the red end of the visible spectrum
Intensification	The process of building up the density of a photographic image by chemical means
Inverse square law	A physical law stating that illumination intensity varies inversely with the square of the distance from a point source of light
Keeper	An acid chemical added to two-solution developers to prevent oxidation of the developing agent
Kodachrome	A commercial monopack produced by Eastman Kodak Company. It is processed by reversal to produce colored positive transparencies.
Latent image	The invisible image formed in an emulsion by exposure to light. It can be rendered visible by the process of development.
Latitude	Exposure latitude is the quality of a film, plate, or paper that allows variation in exposure without detriment to the image quality. Development latitude is the allowable variation in the recommended developing time without noticeable difference in contrast or density.
Lens shade	A detachable camera accessory used to shield the lens from extraneous light rays
Line screen	A finely lined glass screen used in photomechanical reproduction to produce halftone negatives; often referred to as a halftone screen
Lumen	A measurement of light equivalent to that falling on a 1-foot-square surface that is 1 foot away from a point light source of 1 candle power
Magenta	A reddish-blue (minus green) color
Masking	A corrective measure used in three-color photography to compensate for the spectral absorptive deficiencies in pigments, dyes, and emulsions. This compensation improves the accuracy of color reproduction.

Matrix	A gelatin relief image used in the washoff relief process of color photography
Metol	A popular reducing agent sold under such trade names as Elon, Pictol, and Rhodal. The chemical name is monomethyl paraminophenol sulfate.
Monochromatic	A single color
Monopack	Another name for an integral tripack
Mottling	A spotty or granular appearance of either negatives or prints. Uneven development is one of several causes.
M-Q	An abbreviation for Metol-hydroquinone
Negative	A photographic image on film, plate, or paper in which the dark portions of the subject appear light and the light portions appear dark
New coccine	A red, water-soluble dye used for dodging negatives
Nitrate base	The term used to designate a photographic film base composed of cellulose nitrate; highly flammable
Nodal points	The points on the axis of a lens such that a ray entering the first medium, toward the first nodal point, emerges from the second medium in a parallel direction and appears to originate at the second point. The focal length of a lens is measured from the emerging nodal point to the focal plane.
Nonhalation	See "Antihalation backing."
Objective	The term applied to a lens that is used to form a real image of an object
Opacity	The resistance of a material to the transmission of light
Opaque	Refers to an object that is incapable of transmitting visible light; a commercial preparation used to block out certain negative areas
Optical axis	See "Axis of lens."
Orthochromatic film	A film, the color sensitivity of which includes blue, green, and some of the yellow; not sensitive to red

Orthochromatic rendition	The reproduction of color brightness in their relative shades of gray
Orthonon	A film whose color sensitivity includes ultra violet and blue; often called color-blind film
Oxidation	The process of combining a substance with oxygen
Panchromatic film	A film that is sensitive to all colors of the visible spectrum
Parallax	The apparent displacement of an object seen from different points; commonly encountered in photography in the difference between the image seen in the viewfinder and that actually taken by the lens
Perspective	The illusion of three dimensions created on a flat surface
pH	The acidity or alkalinity of a solution expressed in terms of the hydrogen ion concentration. A neutral solution has a pH of 7.0; an acid solution, below this value; and an alkaline solution, above it.
Photomontage	A picture composed of several smaller pictures
Photosensitive	A term used to describe substances whose chemical composition is altered by light
Pincushion distortion	A term applied to the pincushion-shaped image of a square object obtained when the diaphragm is placed behind the lens
Pinhole camera	A camera that has a pinhole aperture in place of a lens
Pinholes	Minute transparent spots in a negative that show up as black spots in a print. The most frequent cause is dust on the film.
Polarized light	Light that vibrates in one manner only - in straight lines, circles, or ellipses. Light is commonly polarized by passing a light beam through a Nicol prism or a polarizing screen.
Pola screen	A screen that transmits polarized light when properly oriented with respect to the vibration plane of the incident light. When rotated to a 90° angle, it will not transmit the polarized light.
Positive	The opposite of a negative; any print or transparency made from a negative

Preservative	A chemical, such as sodium sulfite that, when added to a developing solution, tends to prolong its life
Primary color	Any one of the three components of white light (blue, green, and red)
Proof paper	Usually a printing-out paper that is exposed in contact with the negative to any bright light and does not require a developing solution to make a visible image. The image must be observed in subdued light or it will become dark and eventually disappear.
Proportional reducer	A chemical reducing solution that reduces the silver in the shadows at the same rate as that in the highlights
Radiant energy	A form of energy of electromagnetic character. All light that causes a photochemical reduction is radiant energy.
Reciprocity law	A law stating that the blackening of photosensitive materials is determined by the product of light intensity and time of exposure. Thus intensity is the reciprocal of time and, if one is halved, the other must be double to obtain the same blackening.
Redevelopment	A step in the intensifying or toning procedure when a bleached photographic image is redeveloped to give the desired results
Reducer	A chemical solution used to decrease the all-over density of a negative or print
Reducing agent	The ingredient in a developer that changes the subhalide to metallic silver; usually requires acceleration
Reflection	The diversion of light from any surface
Reflector	Any device used to increase the efficiency of a light source. Examples are flashlight reflectors and tinfoil reflectors for outdoor pictures.
Refraction	The bending of a light ray when passing obliquely from one medium to a medium of different density
Resolving power	The ability of a lens to record fine detail or of an emulsion to reproduce fine detail
Restitution	Projection printing for reducing the variation in the scale of prints

Restrainer	Any chemical such as potassium bromide that, when added to a developing solution, has the power of slowing down the developing action and making it more selective
Reticulation	The formation of a wrinkled or leatherlike surface on a processed emulsion due to excessive expansion or contraction of the gelatin caused by temperature changes or chemical action
Retouching	A method for improving the quality of a negative or print by use of a pencil or brush
Reversal	A process by which a negative image is converted to a positive. Briefly, a negative is developed, reexposed, bleached, and redeveloped to form a positive.
Revolving back	A camera back that can be revolved so that either a vertical or horizontal picture may be obtained; usually found in the heavier types of cameras, such as press or view cameras
Safelight	A light, the intensity and color range of which are such that it will not affect sensitive materials
Safety base	See "Acetate base."
Scale	The ratio of a linear dimension in the photograph to the corresponding dimension in the subject
Schiener scale	A European system of speed ratings for films; little used in this country; abbreviation, Sch.
Secondary colors	Colors formed by the combination of two primary colors. Yellow, magneta, and cyan are the secondary colors.
Selective absorption	The capacity of a body for absorbing certain colors while transmitting or reflecting the remainder
Sensitizer	Dyes used in the manufacture of photographic emulsions. Sensitizers can be of two types: one to increase the speed of an emulsion; the other to increase its color sensitivity
Sensitizing dyes	Dyes used to extend the color sensitivity of an emulsion. Applied during the manufacture of emulsions to obtain selective sensitivity to colored light.

Sensitometer	A device for producing on sensitized material a series of exposures increasing at a definite ratio. Such a series is needed in studying the characteristics of an emulsion.
Sensitometric strip	A series of densities in definite steps
Separation negatives	Three negatives, each of which records one of the three colors: blue, green, and red.
Sepia toning	A process that converts the black silver image to a brownish image. The image can vary considerably in hue, depending on the process, the tone of the original, and other factors.
Short-stop bath	A solution containing an acid that neutralizes the developer remaining in the negative or print before it is transferred to the fixing bath
Shutter	On a camera, a mechanical device that controls the length of time light is allowed to strike the sensitized material
Sludge	A chemical precipitate or impurities that settle to the bottom of the container
Sodium thiosulfate	See "Hypo."
Soft	A term used in describing prints and negatives that have low contrast
Spectrum	The colored image formed by the dispersion of white light when it passes through a prism
Spherical aberration	A lens defect that causes rays parallel to the axis and passing near the edge of a positive lens to come to a focus nearer the lens than the rays passing through the center portion
Spotting	The process of removing spots and pinholes from a negative or print
Squeegee	Either a rubber roller or a strip of rubber held firmly in place on, and used for removing excess moisture from, a flat surface; commonly used in ferrotyping prints
Stock solution	Photographic solution in concentrated form and intended to be diluted for use
Stop	See "Diaphragm."
Subtractive process	A process in color photography using the colors magenta, cyan, and yellow; contrasted with additive color process

Subtractive reducer	A reducer that affects the shadows in a negative without noticeably affecting the highlights
Superproportional reducer	A reducing solution that lowers the highlight density faster than it affects the shadow density
Swinging back	A camera back that can be swung through a small arc so that the divergence or convergence of parallel lines in the subject can be minimized or eliminated.
Synchroflash	A term applied to flash photography in which a flashbulb is ignited at the same instant the shutter is opened, the flashbulb being the primary source of illumination
Synchrosun	A term used in flash photography where flashlight and sunlight are used in combination
Synchronizer	A device for synchronizing the shutter of a camera with a flashlamp so that the shutter is fully opened at the instant the lamp reaches its peak intensity
Time-gamma-temperature curve	A curve of developing time plotted against developed contrast or gamma. The contrast for any given time may be read directly from the curve, or vice versa. The curve applies only for one particular developer and emulsion.
Tone	In photography this usually applies to the color of a photographic image or, incorrectly, to any distinguishable shade of gray
Toning	A method for changing the color, or tone, of an image by chemical action
Translucency	A medium that passes light but diffuses it so that objects cannot be clearly distinguished
Transmission	The ratio of the light passed through an oject to the light falling on it
Transparency	An image on a transparent base that must be viewed by transmitted light; also refers to the light-transmitting power of the silver deposit in a negative and is the opposite of opacity
Tungsten	A metallic element of extremely high melting point used in the manufacture of incandescent electric lamps. In photography, tungsten refers to artificial illumination as contrasted to daylight. For example, film emulsion speeds are given both in tungsten light and daylight.

Ultraviolet rays	Rays that comprise the invisible portion of the electromagnetic spectrum just beyond the visible violet. Ultraviolet wavelengths are comparatively short and therefore disperse more easily than visible wavelengths. This is a factor to be taken into account in high-altitude photography since these rays are photographically actinic.
Vernier scale	A device used on a camera to indicate object distance
Viewfinder	A viewing instrument attached to a camera, used to obtain proper composition
Vignette	Ordinarily refers to a dodging method used in projection printing. A process regulating the distribution of the light that reaches the print in such a way that the image obtained fades out toward the edges. May also be a device placed in front of a camera lens and designed to shade off the margins of a picture to improve its pictorial quality. Used considerably in portrait work.
Visible light	The small portion of electromagnetic radiation that is visible to the human eye; approximately the wavelengths from 400 to 700 nanometers
Working solution	A photographic solution that is ready to use

DEVELOPER

	Developer	Use: film(F) or paper(P)	Dilution for use	Metol (Elon, etc.)	Sodium sulfite	Hydro-qui-none	Sodium carbonate (desic-cated)	Sodium carbonate (mono-hydrated)	Potas-sium bromide	Potas-sium meta-bisul-fite	Sodium hydrox-ide
											Contents,
1	Ansco 17 (fine grain; tank)	F	None	1.5	80.0	3.0			0.5		
2	Ansco 17M (fine grain; tank)	F		1.5	80.0	3.0			.5		
3	Ansco 20 (positive; normal contrast)	F Pos		2.0	25.0	4.0		18.5	2.0		
4	Ansco 22 (cine; title and positive)	F		.8	40.0	8.0		50.0	5.0		
5	Ansco 30 (x-ray)			3.5	60.0	9.0		40.0	2.0		
6	Ansco 40 (tray)		1:2	4.5	54.0	7.5		54.0	3.0		
7	Ansco 42 (soft working)		None	.8	45.0	1.2		8.0	1.5	4.0	
8	Ansco 47 (long-life standard sheet)		1:1	1.5	45.0	3.0		6.0	.8		
9	Ansco 47 (press; rapid)		None	2.7	81.0	5.4		21.0	1.5		
10	Ansco 48M (deep tank)			2.0	40.0	1.5			.5		
11	Ansco 61 (tray)			1.0	15.0	2.0		15.0	1.0		
12	Ansco 64 (rapid; tropical)			2.5	25.0	6.5		16.0	1.0		
13	Ansco 70 (process; caustic)					25.0			25.0	25.0	36.0
	Ansco 72 (glycin):										
14	Tank		1:15		125.0			K_2CO_3 [a]			
15	Tray		1:4					250.0			
16	Ansco 79 (litho)		None		30.0	22.5			1.5	2.6	
17	Ansco 81 (long-life litho)		None		55.0	35.0		80.0	10.0		
18	Ansco 90 (high-contrast; tray)		None	5.0	40.0	6.0		40.0	3.0		
19	Ansco 103 (cold blue-black tones)	P	1:2	3.5	45.0	11.5		78.0	1.2		
20	Ansco 110 (warm brown-black tones)		1:5		57.0	22.5		75.0	2.75		
21	Ansco 113 (Amidol paper)		None		44.0				.55		
22	Ansco 115 (warm tone)		1:3		90.0	9.5		150.0	4.0		
23	Ansco 120 (soft working)		1:2	12.3	36.0			36.0	1.8		
24	Ansco 125	F-P	1:1, 1:2	3.0	44.0	12.0		65.0	2.0		
25	Ansco (rapid; two bath)	F	None	5.0	30.0	10.0		(100) [b]			
26	Ansco 130 (universal paper)	P	1:1	2.2	50.0	11.0		78.0	5.5		
27	DuPont ND1 (negative; cine)	F	None	.8	90.0	1.0					
28	DuPont ND2 (tank or tray)			2.5	75.0	3.0					
29	DuPont ND3 (fine grain)				90.0						
30	DuPont ND4 (low contrast)			.4	50.0	2.2					
31	DuPont PD1 (positive; rapid; high contrast)			1.4	60.0	6.2		56.0	1.8		
32	DuPont PD3 (positive; normal contrast)	F	None	.5	40.0	5.0		12.0	1.0		
33	DuPont PD5 (positive; maximum contrast)	F	None	1.5	60.0	15.0		64.0	4.5		
34	DuPont LD1 (litho; extreme contrast)	F	None		30.0	22.5			1.5	2.5	

[a] Potassium carbonate.
[b] Second bath.

COMPARISON CHART

Sodium metaborate (Kodalk)	Glycin	Sodium sulfate	Paraformaldehyde	Potassium thiocyanate	Borax	Boric acid (crystal)	Citric acid	Sodium bisulfite	Paraphenolene diamine base	Amidol	Pyro	Antifoggant	Para aminophenol hydrochloride	Potassium iodine	
g/liter															
					3.0										1
2.0															2
								1.8							3
															4
															5
															6
															7
								1.0							8
								1.8							9
10.0															10
															11
															12
															13
	50.0														14
															15
			7.5			7.5									16
							5.5								17
															18
															19
															20
										6.6					21
	30.0														22
															23
															24
															25
	11.0														26
					3.0										27
					5.0										28
	2.0								10.0						29
					1.2		.4								30
															31
															32
															33
			7.5			7.5									34

	Developer	Use: film(F) or paper(P)	Dilution for use	Metol (Elon, etc.)	Sodium sulfite	Hydro-quinone	Sodium carbonate (desic-cated)	Sodium carbonate (mono-hydrated)	Potas-sium bromide	Potas-sium meta-bisul-fite	Sodium hydrox-ide
											Contents,
35	DuPont LD2 (litho; long life)	F	None		30.0	26.0		60.0	4.0	10.0	
36	DuPont XD20 (x-ray)			5.0	60.0	7.5		58.5	4.5		
37	Kodak D-8 (high-contrast process)				90.0	45.0			30.0		37.5
38	Kodak D-11 (high-contrast process)			1.0	75.0	9.0	25.0		5.0		
39	Kodak D-13 (tropical; process)				52.5	10.5	52.5				
40	Kodak D-15 (tropical)			5.7	90.0				1.9		
41	Kodak D-15a (tropical; low contrast)			5.7	90.0				1.9		
42	Kodak D-16 (cine; positive; tank)			.31	39.6	6.0	18.8		.86	1.5	
43	Kodak D-19 (rapid; high contrast)			2.2	96.0	8.8	48.0		5.0		
44	Kodak DK-20 (fine grain)			5.0	100.0				.5		
45	Kodak DK-30 (variable width; sound negative)			6.0	30.0	3.0			1.0		
46	Kodak D-32 (lantern slide; warm)	(c)			6.3	7.0	30.0		3.5		4.2
47	Kodak DK-40 (cine; positive)	F		1.0	30.0	4.0			.25		
48	Kodak D-41 (photomicro; low contrast)	F		2.0	100.0	5.0					
49	Kodak D-42 (photomicro; normal contrast)	F		2.0	100.0	5.0					
50	Kodak DK-50			2.5	30.0	2.5			.5		
51	Kodak DK-52 (portrait paper)	P		1.5	22.5	6.3	15.0		1.5		
52	Kodak DK-60a (deep tank or machine)	F		2.5	50.0	2.5			.5		
53	Kodak DK-60b (aero)	F		1.25		1.25			.25		
54	Kodak D-61a (tray or tank)	F	1:1, 1:3	3.1	90.0	5.9	11.5		1.7		
55	Kodak D-72 (universal)	F-P	1:1, 1:2	3.1	45.0	12.0	67.5		1.9		
56	Kodak D-76 (low contrast)	F	None	2.0	100.0	5.0					
57	Kodak D-82 (high energy)	F		14.0	52.5	14.0			8.8		8.8
58	Kodak D-85 (litho; extreme contrast)	F			30.0	22.5			1.6	2.6	
59	Kodak D-88 (direct; positive)	P			48.8	24.4			2.6		24.4
60	Kodak D-91 (Kodelon; tropical)	F			50.0		50.0				
61	Kodak DK-93				30.0	2.5			.5		
62	Kodak D-103			2.0	100.0	5.0			.125		
63	Kodak SD-1 (stain image)				1.4		5.3				
64	Kodak D-23 (low contrast)			7.5	100.0						
65	Kodak D-25 (fine contrast)			7.5	100.0						

[c]Glass lantern slide plates.

Sodium metaborate (Kodalk)	Glycin	Sodium sulfate	Paraformaldehyde	Potassium thiocyanate	Borax	Boric acid (crystal)	Citric acid	Sodium bisulfite	Paraphenolene diamine base	Amidol	Pyro	Antifoggant	Para aminophenol hydrochloride	Potassium iodine	
g/liter															
															35
															36
												0.2%			37
															38
		45.0											5.2	2.1	39
22.5		45.0													40
5.0		45.0													41
							0.68								42
															43
2.0				1.0											44
4.0															45
							.7								46
20.0															47
					2.0							5 ml			48
10.0					2.0							10 ml			49
10.0															50
															51
20.0															52
10.0		50.0						25.0				8 ml			53
								2.1							54
															55
					2.0										56
									48 ml						57
			7.5			7.5									58
						5.6									59
													7.0		60
20.0													5.0		61
					1.0	15.0									62
											2.8				63
															64
								15.0							65

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Compiled by Ernie D. Walker.

16. Abstract

This work is intended as a reference of black-and-white photographic chemistry. Included is a basic history of the photographic processes and a complete description of all chemicals used, formulas for the development and fixation process, and associated formulas such as cleaners, hardeners, and toners. The work contains a complete glossary of photographic terms, a trouble-shooting section listing causes and effects regarding photographic film and papers, and various conversion charts.

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