Mix Your Own Darkroom Chemicals

Here's how to fine-tune formulas for personalized processing

By David Vestal

Few black-and-white photographers mix their own processing chemicals from formulas any more, but those who don't may be missing something.

For years the raw materials got harder and harder to find, but that has changed. The big companies have cut down severely on these chemicals, but new, small companies have started up to meet a growing demand. You can now order almost any photographic chemical, for current processes and historic ones, by mail.

That's good news for me, because I prefer some things I mix at home to anything similar that I can buy ready-made. You might, too.

Let's dispose of the arguments. The questions are: 1) Why bother? 2) Aren't ready-made chemicals better? 3) Don't they offer everything you could want?

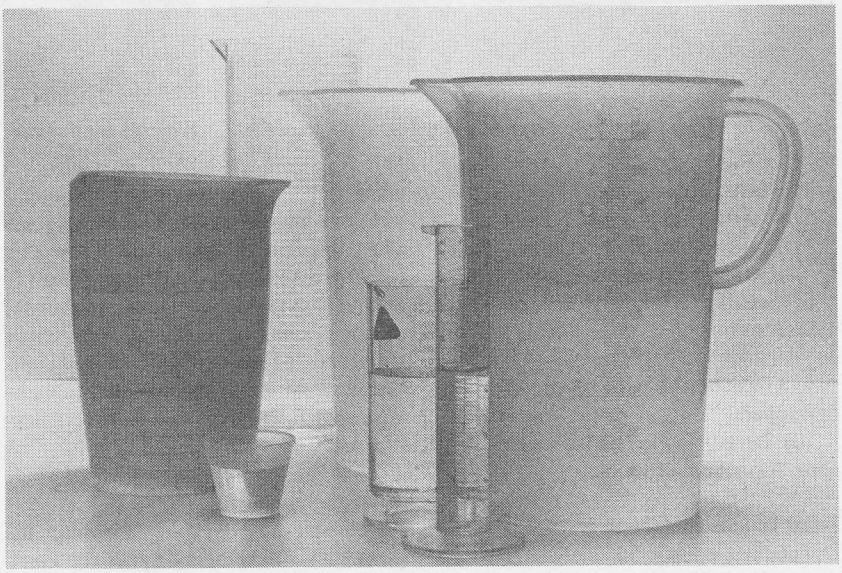
The answers are: 1) Because mixing my own chemicals helps me do my work the way I want to. 2) No. My home brews work as well or better, and some of them last longer in the bottle and the tray. 3) No. Some of my favorite developers and fixers can't be bought in any photo store.

When I mix a developer or fixer, I know what's in it and what each ingredient does, so if need be, I can change a formula to get the results I want. And when you've just mixed a processing chemical, you know it's fresh.

Once you have your recipe collection, no manufacturer can force you to change your way of working by discontinuing their Miracle-Glop. You're independent.

Formulas give you choices. A great many different ones are available to serve many purposes.

If you buy the chemicals you use most in bulk, you can save money. For instance, it takes two pounds of hypo crystals (sodium thiosulfate, pentahydrated) to make a gallon of fixer. Every few years, when my supply starts to get low, I buy another 100 pounds of hypo. I never buy it one pound at a time. The hundred pounds I'm now halfway through cost me $49.52 in 1978. It's now listed by Kodak at $3.15 per single pound. I saved a few dollars there. There are lower prices than Kodak's. A catalog from Lauder Chemical in California offers "sodium thiosulfate, prismatic" (same thing) at $1.50 per one-pound bottle or $18.65 per 25-pound drum, or about 75 cents a pound. Even with coast-to-coast shipment, the 25-pound drum comes to $1.17 per pound. So there are ways.



You should have graduates like these: largest one holds two liters, smallest holds 30 ml.

The other things you'd be likely to buy in bulk are sodium sulfite, anhydrous; and sodium carbonate, monohydrated. You use a lot of both when you mix your own. Kodak now lists sodium sulfite at $3 per single pound and at $9.55 for five pounds, which comes to $1.91 a pound. You pay less for it when you buy more.

Most chemicals are best bought in small amounts unless you're doing a great deal of work.

You need not stock many items: most photographic formulas use varying combinations of the same few fundamental ingredients.

Final argument: You can take some pride in doing things well for yourself. It's a pleasure. Case rests.

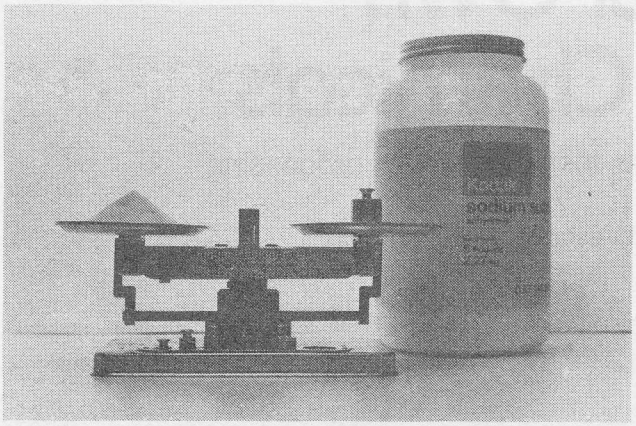
What you need: equipment

1) Balance for weighing chemicals, capacity 100 grams or more, and a set of weights; two grams to 50 grams will do. (Or kitchen measuring spoons can be used instead; Zone V, Inc., publishes weight-to-volume conversions for this.)

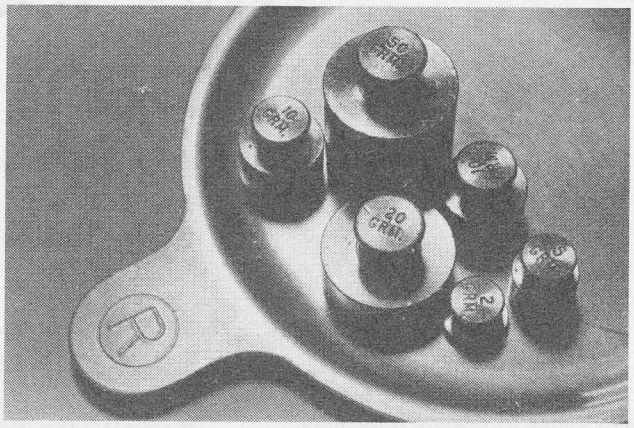
2) Thermometer that reads from below 20 C/68 F to above 52 C/125 F.

3) Two-to-three gallon plastic pail for mixing solutions.

You need a way to weigh out the chemicals



Pelouze balance: weights go on one side, chemicals on other.



Weights for this unit add up to 97 grams, sliding bar adds three.

4) Plastic stirring rods.
5) Plastic or stainless-steel spoon.
6) Plastic funnels.
7) Two large (two-liter) graduates.
8) Small graduates to measure liquids from five or 10 ml to 100 or 150 ml or more.
9) Glass bottles with plastic caps, for developers.
10) Large plastic bottles with plastic caps, for other solutions.

What to get: chemicals

Developing agents

1) Metol (Kodak trade name, Elon; p-methylaminophenyl sulfate): one pound.
2) Hydroquinone: one pound.

Preservative

3) Sodium sulfite, anhydrous: five pounds.

Alkaline accelerator

4) Sodium carbonate, monohydrated: five pounds.

Restrainer

5) Potassium bromide, anhydrous: one pound.

Fixer (hypo)

6) Sodium thiosulfate, pentahydrated: 25 to 100 pounds.

Hardener

7) Potassium alum: one pound.

Other chemicals

8) Glacial acetic acid: one gallon.
9) Sodium metaborate (Kodak trade name, Kodalk Balanced Alkali): one pound.
10) Sodium bisulfite, anhydrous: one pound.
11) Silver nitrate crystals: 10 grams.

This is a basic selection. If you like what these things do for you enough, you may want to go further and try another developing agent, best known by its Ilford trade name, Phenidone (1-phenyl-3-pyrazolidone); and another restrainer, benzotriazole (Kodak trade name, Anti-Fog No. 1). The possibilities of ammonium thiosulfate for making rapid fixers may also be worth trying out.

What the chemicals do

Developers usually have five main ingredients: a developing agent (or two), a preservative, an accelerator, a restrainer (sometimes two), and a solvent (water).

Developing agents change the light-exposed silver salts in the film or paper into metallic silver, more or less in proportion to the amount of exposure. The developing agents have little effect on unexposed silver salts. There are "soft-working" or low-contrast developing agents and "contrasty-working" ones.

Metol and Phenidone are "soft" and work with about equal energy on both little-exposed and much-exposed parts of pictures, so contrast builds up gradually. Of the two, Phenidone is more powerful and is used in smaller quantities. In many formulas $\frac{1}{5}$th to $\frac{1}{10}$th the amount of Phenidone can replace the amount of metol called for by the formula. Metol gives some people an allergic skin reaction, but Phenidone is nonallergenic. Metol is used either with hydroquinone or by itself in many formulas; Phenidone is usually used together with another developing agent, often hydroquinone.

Hydroquinone is "contrasty-working," since it acts first and most strongly on the more-exposed parts of the picture and thus builds up the contrast relatively quickly. It is seldom used alone, but usually with metol or Phenidone, both of which give it a catalytic boost that makes the hydroquinone act far more powerfully than it can alone. Phenidone boosts hydroquinone more than metol does.

A developer's contrast performance can be controlled by varying the proportion of "hard" hydroquinone to "soft" metol or Phenidone. The less hydroquinone, the "softer" the developer.

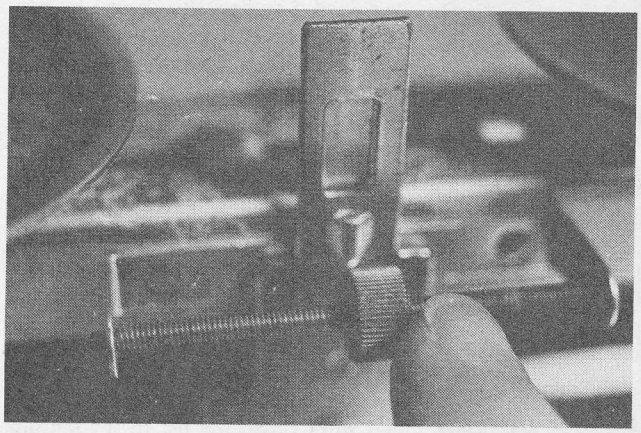
The *preservative,* sodium sulfite, greatly slows down the oxidation of the developing agents. It combines with oxidation byproducts as fast as they form, keeping the developer from turning brown and keeping it fresh.

The *accelerator* or activator is an alkali that speeds up and strengthens the developer's action. The stronger the alkali, the more vigorous the development action.

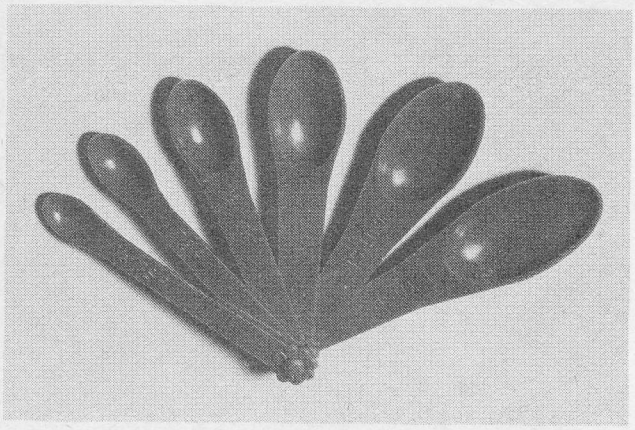
Alkalinity and acidity are opposites, and degrees of both are expressed in pH numbers, from 1 (extreme acidity) through 7 (neutrality) to 14 (extreme alkalinity). Alkaline solutions feel soapy and slippery to the touch, and acid ones don't, so you can tell which is which even without a pH meter.

Most paper developers use sodium carbonate, a fairly energetic alkali; most film developers use weaker ones.

Restrainers keep the unexposed parts of negatives and prints from being developed into thin, featureless silver de-



Zero adjustment is on the back of balance.



Another is spoon-weighing method from Zone V, Inc.

posits called "fog." A fogged print is gray where you want it to be white.

Potassium bromide is the usual restrainer, but in Phenidone developers bromide is not fully effective, so benzotriazole is added to their formulas. In metol and metol-hydroquinone developers, either restrainer can be used alone.

Restrainers also affect print color. Potassium bromide gives prints slightly greenish grays and blacks, while benzotriazole gives more blue-black tones.

The *stop bath* is a weak solution of acetic acid that is used after the developer. It stops development abruptly and de-alkalizes the film or paper; this helps keep the fixer fresh.

The *fixer* or *hypo* removes unused silver salts from developed film or paper. These light-sensitive salts would otherwise darken and wipe out the picture.

Hypo itself is harmful to photographs and must be removed thoroughly if they are to last long. Careful fixing and washing are imperative.

For complex chemical reasons, most sodium thiosulfate fixers also contain sodium sulfite, acetic acid, alum, and often other ingredients.

The *hardener* is potassium alum. It tans and toughens the gelatin that holds the silver image to prevent damage while wet film and paper are handled, washed, and dried. Hardening also helps photographs kept in humid climates resist fungus infection.

But alum is not all good. It slows the washing out of hypo, especially from paper; and too much hardening can make prints brittle and curly.

A *washing aid,* sometimes wrongly called "hypo eliminator," is a chemical bath that helps the hypo wash out of film and paper more readily.

In 1943, Kodak tests for the U.S. armed forces showed, to everyone's surprise, that sea water washed hypo out of photographs much faster than fresh water. Something about salt water did it—they didn't know what. But salt—sodium chloride—is bad for photographs, and it had to be washed out with fresh water.

After much research, variations on the salt-water idea resulted in the introduction of various harmless chemical solutions that had the same effect of helping the hypo wash out. These are washing aids.

Few washing-aid formulas have been published, since this is the age of the trade secret. But we have one here.

Test solutions

There are formulas made not to process pictures but to check up on their condition, and on the condition of processing chemicals.

One useful one is Kodak's HT-2 formula for testing the thoroughness of film and print washing. You can buy it ready-made, but it's hard to find in photo stores and it's much cheaper to mix than to buy.

Weighing with a balance

I'll describe how my balance works, since it's entirely conventional.

There's a left-hand pan where you put the chemical you're weighing, and a right-hand pan for the weights. A calibrated horizontal bar with a sliding weight allows for quantities that don't match standard weights.

You set up the right-hand pan and the sliding weight for the quantity you want, then add the chemical to the left pan until the two sides balance. Engraved marks match when the balance is reached. That's all there is to it.

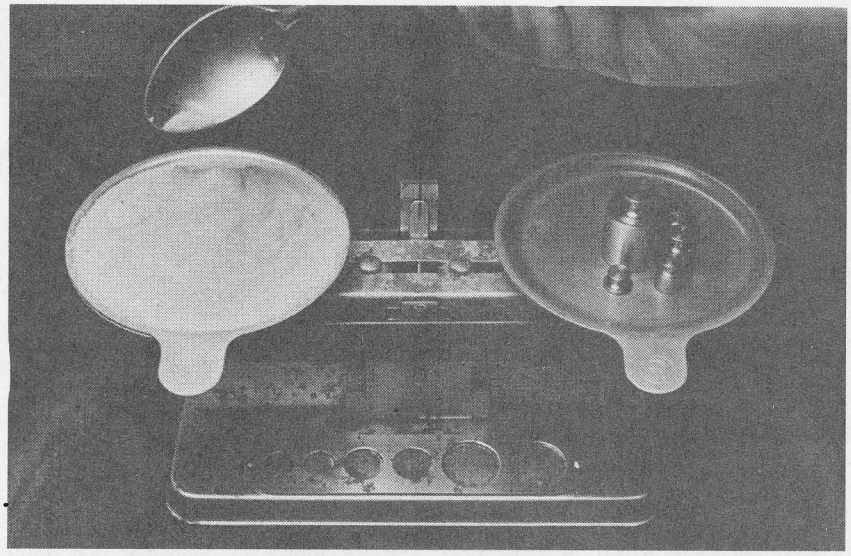
But first zero the balance with the pans empty. On the back of my scale is a threaded rod with a brass adjustment wheel that moves right or left when turned. The balance is zeroed when the engraved marks line up exactly after the balance swings and comes to rest.

Don't get the pans mixed up. The one marked "L" should stay on the left, and "R" on the right. They may not weigh the same. Mine, when switched, cause a 20-gram discrepancy—this is far too much.

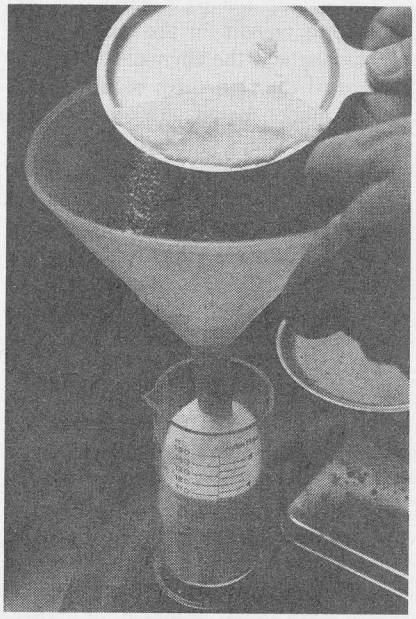
Proper chemists put paper on the balance pan under the chemical they're weighing, to keep the balance scrupulously clean. Each chemical, of course, needs fresh paper. I'm an improper photographer, so I'd rather skip the paper and just rinse and wipe the balance pan after each ingredient has been weighed.

A small balance that can only weigh 100 grams at a time makes for slow work when you must weigh out, say, 320 grams of something; and with such repeated weighings, you can lose count. It makes sense to convert such large weights into measurement by volume. Weigh out the 320 grams of that chemical once and put it in a graduate which will show the exact volume it occupies.

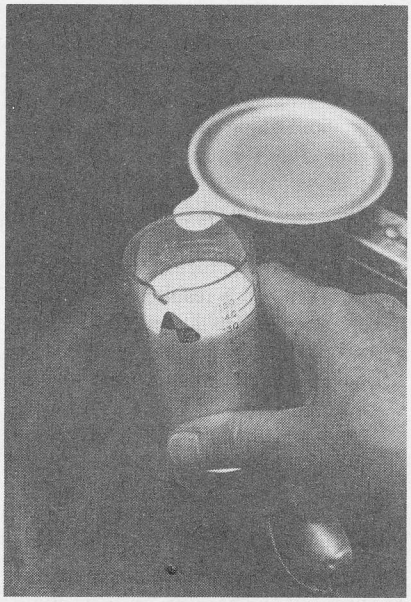
It's convenient to convert large weights into volume measure



Problem: balance can handle only 100 grams of sodium sulfite.



Solution: weigh out what you need—here, 200 g, then pour into graduate.



Note: 200 grams sodium sulfite is at 130 ml mark. Next time use graduate only.

Then the next time you need 320 grams of that chemical, you just fill the graduate with it up to that volume instead of weighing it on the balance in four stages. This is accurate enough. I have formulas on my darkroom wall, and where I've substituted volume for weight, the volume measure is written into them.

Each chemical has its own weight per volume, and they are not interchangeable. Don't measure sulfite according to the volume per weight of carbonate, or you'll get the wrong amount.

I mix chemicals in my darkroom because no other place will serve as well; but if you can, have your mixing sink and table outside the darkroom. The reasons to mix elsewhere are good ones. Some chemicals—light, fine-textured powders—tend to float around in the air and can cause trouble where they settle. If they get on undeveloped film or paper, those negatives or prints may be ruined. I respect this danger by handling all chemicals as neatly and gently as I can. I never wave them around or dump them casually from the spoon into the balance pan, nor do I ever blow on the pan to clear a powder off it. A water rinse and a paper-towel wipe do it better. The spoon, as well as the balance pan, is cleaned and wiped before it touches the next chemical.

Mixing chemicals from formulas

The procedures are simple. Formulas are published in the mixing order, so always dissolve the top ingredient first and work down the list to the bottom. Mixing in any other order may give you some useless, unknown solution that isn't the processing chemical you started out to mix.

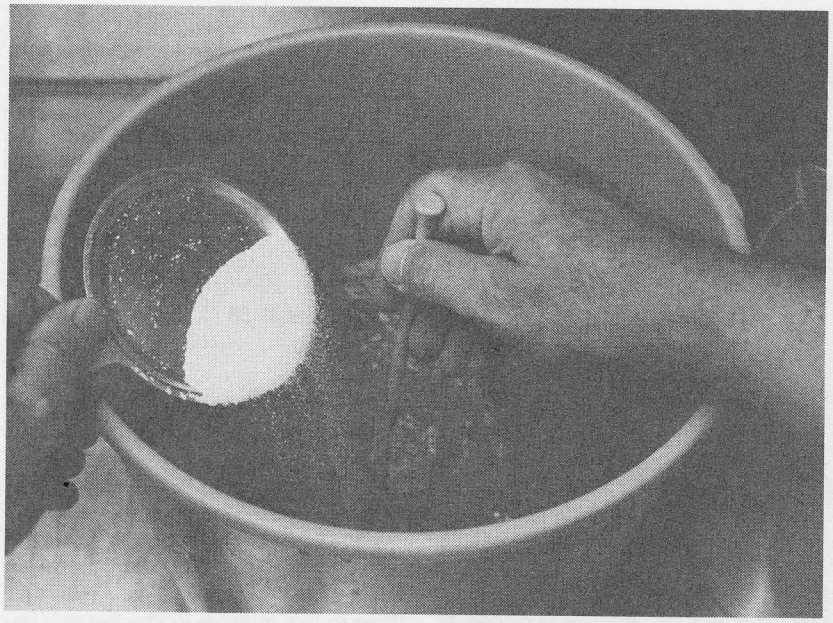
First measure out water in the amount and at the temperature given in the formula and put it in the mixing pail. If no temperature is given, then tap water as it comes from the cold faucet will do. (Any clear, colorless, odorless tap water is okay for photographic chemicals. Otherwise use distilled or deionized water.)

Next, weigh out the first chemical and add it slowly to the water while stirring smoothly and rapidly so it won't settle on the bottom. Don't stir so hard that you beat air into the water; but if you don't stir enough, or if you add the chemical too quickly, it may cake on the bottom of the pail and take a long time to dissolve.

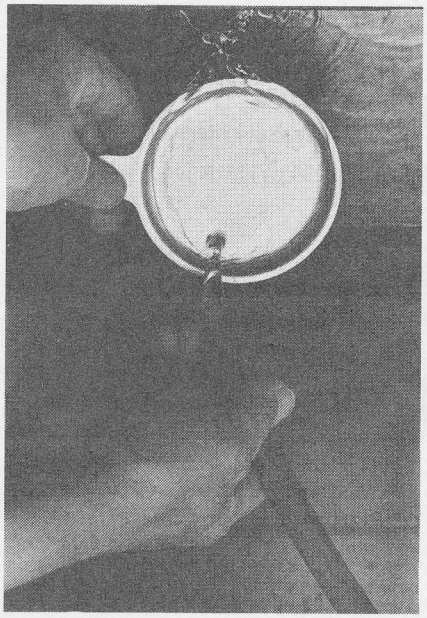
When the first ingredient is completely dissolved, then measure out, add, and stir in the next one in the same way. When it's fully dissolved, go on to the next chemical, and so on. Each ingredient should be completely dissolved before you add the next.

When one ingredient is a liquid (as the acetic acid is in fixer formulas), stir it as long and well as any powder that needs to be dissolved. It must be mixed in thoroughly before you add the next chemical.

The "water-to-make" step brings the volume of the solution up to the final amount you're after. Before adding any water, if you want, say, four liters of a developer, pour two liters of your mix from the mixing pail into a large graduate; then pour the rest into a second graduate and add enough cold water to



Normal procedure is to pour chemicals, in proper order, directly into mixing bucket.



In-between weighing out chemicals, thoroughly wash and dry the balance pan.

bring the volume in this second graduate up to two liters.

Empty both graduates back into the mixing pail and stir until the mixture is uniform. Then funnel the solution into a clean bottle or bottles.

For developers, which will oxidize in most plastic bottles, I use glass bottles filled to the top so no air is in them. A good size for developer bottles is the amount of developer you want to use at a time: then you use up one bottle completely each time you work, and the rest stay sealed and fresh.

For fixers and washing aids, large plastic bottles make sense. I use gallon and five-quart ones.

Label each bottle and its cap and put the mixing date on the bottle so you'll know how old the solution is. Masking tape or freezer tape and a laundry marker are very good for waterproof labeling.

With fixer and other reusable solutions, put a strip of tape on the bottle and write on it the number of films or prints treated, keeping it up to date as you go. Then you can avoid overusing the solution. (Exhausted chemicals may produce poor-quality work and are likely to cause eventual stains and fading.)

Mixing order

If you're mixing more than one kind of solution, mix them in the order in which they're used in processing. That is, mix developer before you mix fixer, and mix fixer before washing aid. The pail should always be cleaned well between them anyway; but contamination of one solution by another in the processing sequence does less harm than in the reverse order.

Note: metol is always listed above sodium sulfite in formulas because metol won't dissolve in a sulfite solution. All the same, it's a nice refinement to dissolve a tiny pinch of sulfite in the water before you put the metol in. That's not enough sulfite to keep the metol from dissolving, but it's enough to keep it from starting to oxidize as it dissolves. (When you put metol in water with no sulfite at all, it starts to turn brown at once; then when you add the sulfite, it suddenly clears again. But a bit of your metol is wasted.)

Six useful formulas

Formula books usually give quantities to make one liter of any solution; but one liter is seldom the amount a photographer wants to have on hand. I've translated these formulas into the quantities I normally mix for use, figuring that if they're convenient amounts for me, they may also be for you.

It's tedious and unnecessary to spell out everything in full detail at every mention, so these formulas are written in short form. Here's a list of the terms used and what they stand for:

Metol is the same as Kodak Elon.

Sodium metaborate is the same as Kodalk Balanced Alkali.

Sulfite is sodium sulfite, anhydrous (or dessicated).

Carbonate is sodium carbonate, monohydrated.

Bromide is potassium bromide, anhydrous.

Hypo is sodium thiosulfate, pentahydrated (or prismatic).

Alum is potassium alum.

WTM means, add enough cold water to bring the solution up to the volume given.

g means grams.

ml means milliliters (equal to cc or cubic centimeters). 1,000 ml = 1,000 cc = one liter.

Kodak D-72 paper developer

D-72 is the father of Kodak's standard ready-mixed paper developer, Dektol. Of the two, I slightly prefer D-72; it seems to last longer in the bottle and the tray. The formula I use is an old one; the D-72 now published by Kodak

uses more carbonate and bromide than this one. Since the old form works beautifully, I see no need to change it.

To make 4 liters of D-72

Water, 50 C/125 F	3 liters
Metol	12 g
Sulfite	180 g
Hydroquinone	50 g
Carbonate	270 g
Bromide	7½ g
WTM	4 liters

For use, dilute 1 + 2 (one part stock developer plus two parts water); normal development time for prints, two to five minutes.

Ansco 120 paper developer

This is a splendid, low-contrast print developer. It's "soft" because it has only metol—no hydroquinone. On many enlarging papers it yields prints about one grade softer than D-72 or Dektol. It can be mixed with D-72 or Dektol to get a developer of intermediate contrast.

To make 4 liters of Ansco 120

Water, 50 C/125 F	3 liters
Metol	50 g
Sulfite	150 g
Carbonate	150 g
Bromide	7½ g
WTM	4 liters

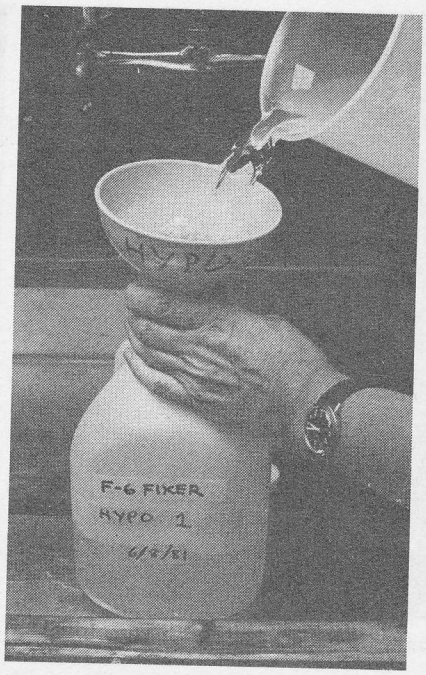
For use, dilute 1 + 2; normal development for prints, two to five minutes.

Kodak stop bath SB-1

This is all the stop bath most photographers need. For simpler measurement, I've rounded Kodak's 48 ml of acetic acid per liter of water to 50 ml. Mix it in the tank or tray just before use: it only takes a few seconds.

To make 2,100 ml of SB-1 stop bath

Water	2 liters
Acetic acid 28 percent	100 ml



For safety's sake use funnel when pouring chemicals. Here author pours freshly mixed F-6 fixer into bottle.

To make less or more, just halve or double these amounts. 2,100 ml is enough stop bath for about 40 8x10-in. prints or rolls of 120 or 35-mm film.

To use, drain the film or print for the last 10 seconds of development time, then put it in the stop bath for five to 30 seconds with agitation. Drain again before putting the film or print in the fixer. Use the stop bath for one work session and discard.

To make 28-percent acetic acid from glacial acetic acid, add three parts of glacial acetic acid to eight parts of water. Handle with care in a well-ventilated space: glacial acetic acid can cause severe skin burns and it gives off powerful, choking fumes.

There is a safety rule for diluting strong acids: *never add water to acid,* because the violent reaction that follows can splash acid in your face; *always add acid to water.*

Kodak F-6 acid hardening fixer

This nearly odorless variation on the Kodak F-5 formula washes out of fiber-base prints more readily than F-5 or its premixed equivalent, Kodak Fixer. That's why I use F-6 for my regular print fixer.

I use it as a two-bath fixer—four liters per bath—so it's convenient to mix F-6 eight liters at a time.

To make 8 liters of F-6 fixer

Water, 50 C/125 F	6 liters
Hypo	2 liters by volume
Sulfite	120 g
Acetic acid 28 percent	380 ml
Sodium metaborate	120 g
Alum	120 g
WTM	8 liters

Use the fixer in two stages. Three to five minutes in "hypo one" removes most of the unused silver salts, and three to five minutes in "hypo two" finishes the job and makes the hypo-silver complexes in the paper soluble so they can be washed out. Two-bath fixing greatly extends fixer life.

Capacity, 100 8x10-in. prints per four-liter bath. After 100 8x10s, discard "hypo one" and use the ex-"hypo two" as "hypo one" for the next 100 8x10s, along with the brand-new "hypo two."

A Kodak research washing-aid

From a 1956 research paper by J. I. Crabtree and R. W. Henn, this formula has since been published by Dignan Photographic, and also by Zone V, Inc., by whose permission I use it here. I've converted it to four liters and to standard mixing procedure. Apparently this formula is similar to Kodak Hypo Clearing Agent; the same treatment times are suggested.

To make ½ liter HT-2 residual hypo test

Water	375 ml
Acetic acid 28 percent	62.5 ml
Silver nitrate	3.25 g
WTM	500 ml

To use: Film: after fixing, rinse for one minute, then treat in washing aid for one minute. Prints: after fixing, rinse one minute, then treat in washing

aid for three minutes. (Based on general experience with washing aids, I suggest increasing these rinse and treatment times by two to five times.) Four liters of washing-aid should treat up to 100 8x10 prints if they have been well rinsed first.

Kodak HT-2 residual hypo test

This is published as a one-liter formula, but no one normally needs that much HT-2, so I've cut the amounts in half. This should still be enough for years.

To make 4 liters of washing aid	
Water	3 liters
Sodium sulfite	80 g
Sodium bisulfite	8 g
WTM.....	4 liters

Put a small amount in a small brown glass bottle with a dropper cap, and keep the rest refrigerated for future reference. You only need one drop per hypo test.

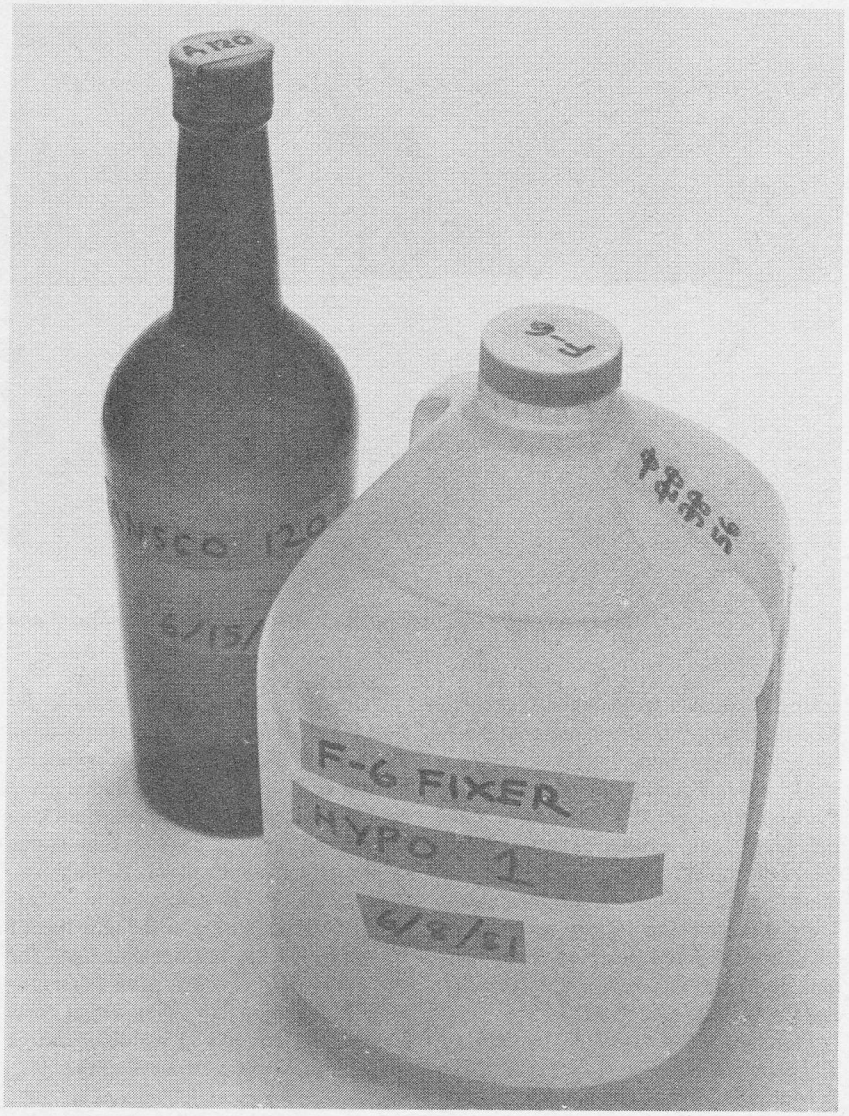
To use: Fix an unexposed sheet of paper along with your prints, and put it through the washing aid and into the wash along with the prints.

When you think the prints might be washed—say, after 30 minutes—cut a small sample from this test sheet and put the rest back in the wash.

Blot surface water drops off the emulsion side of the sample and put one drop of HT-2 solution on it. Do this in subdued light—avoid strong light. After two minutes, blot off the drop and inspect the sample.

A brown or yellow stain means that the wash is far from complete, and the paper still contains much too much hypo. A pale beige stain means you're getting somewhere but haven't arrived yet. When there is no stain at all, or the faintest visible stain, the wash is "fair" and may be good: then wash the prints for another half hour for luck.

This does not guarantee "archival" prints: silver nitrate won't register small quantities of hypo and other chemicals which can, in time, cause stains and fading. It means that you've made a good try. (We do not yet have either an archival standard for prints or a critical test that can assure us of a complete wash.)



Author stores developer in glass bottles to reduce oxidation. For fixer this is not necessary. Note tally showing this fixer was used for 56 8x10-in. prints.

Systems of measurement

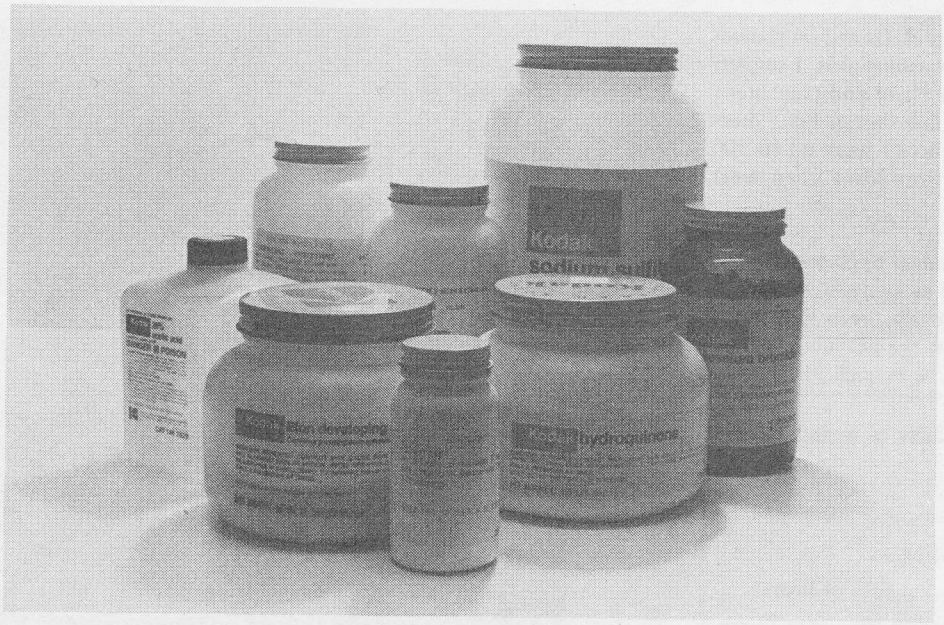
Old formulas are often given in avoirdupois or "U.S. customary" units, while current ones are metric. I have both avoirdupois and metric weights, so I can mix old formulas without conversion; that's a convenience. But I suggest you standardize on metric. It's simple and logical, and it's the international standard system.

I recommend weighing with a balance, which makes any formula simple to use. But there are other ways. Zone V, Inc. publishes a list of standard black-and-white chemicals that tells for each how to convert grams into teaspoons or tablespoons: Zone V formulas are given in metric and in tbl and tsp. This is workable, and seems to appeal to people who are alarmed by the idea of weighing things. For myself, I find weighing easier as well as more accurate and less limiting.

Books with formulas

Here are a few of the many books that give formulas and information about photographic chemistry:

The Compact Photo-Lab Index, Ernest M. Pittaro, editor; Dobbs Ferry, N.Y.: Morgan & Morgan, hardcover, $17.50; paperback, $10.95. Many proc-



Assorted chemicals from author's shelf; some are from Kodak and some from Zone V, Inc.

essing formulas from Agfa-Gevaert, Kodak, GAF, and Ilford, and much additional information.

150 Do-It-Yourself Black and White Popular Photographic Formulas, Patrick D. Dignan, editor; Baywood Park, Ca.: Dignan Photographic, $9.95. A mixed bag of formulas and information, some standard, but largely specialized. (It can be ordered postpaid from Dignan Photographic, Inc., 1712 10th St., Baywood Park, Ca. 93402.)

Photographic Chemistry, by George T. Eaton; Dobbs Ferry, N.Y.: Morgan & Morgan, $6.95. Contains few formulas but is good for its clear treatment of photographic chemistry in layman's language. Mostly for background.

Photo-Lab Index, Lifetime Edition, Ernest M. Pittaro, editor; Dobbs Ferry, N.Y.: Morgan & Morgan, $54.95. Includes much more than the *Compact PLI;* the full-scale *Photo-Lab Index* has been compiling information and formulas from many sources for more than 40 years. (It is updated periodically by supplements for subscribers to this service.) This massive, looseleaf collection includes useful sections on photographic chemicals, weights and measures, special processes, and more. (For information, write to Morgan & Morgan, Inc., 145 Palisade St., Dobbs Ferry, N.Y. 10522.)

Processing Chemicals & Formulas for Black-and-White Photography, Kodak Publication No. J-1, $1.95. A solid collection of Kodak formulas and a great deal of clearly written information. Can be ordered through photography stores or directly from Eastman Kodak Co., Dept. 454, 343 State St., Rochester, N.Y. 14650. (For a complete list of Eastman Kodak publications, ask for the current *Index to Kodak Information,* Publication No. L-5, which costs 25 cents.) There is a $1 handling charge on each book order from Kodak.

Where to get chemicals

There are other sources. These are the ones I know of at present.

Eastman Kodak Co., 343 State St., Rochester, N.Y. 14650. Kodak Tested Chemicals can be ordered through most large photo stores and can be bought off the shelf in some. A consumer catalog, *Kodak 1981-82 Photographic Products Reference Guide,* Publication No. R-50 ($3), lists standard photographic chemicals, but omits bulk quantities of some, which are nevertheless available. It may help to know some of their catalog numbers: CAT 194 3125 is a 100-pound bag of sodium thiosulfate, pentahydrated; CAT 140 1124 is a 100-pound drum of the same.

Lauder Photographic, Inc., 350 Peninsula Ave., San Mateo, Ca. 94401; telephone (415) 348-2026. Photographic chemicals in small and bulk quantities. Write for catalog and price list. Direct mail order. Ships by United Parcel Service.

Mallinckrodt, Inc., P.O. Box M, Paris, Ky. 40361. Some photographic chemicals can be ordered through dealers; write to Mallinckrodt for nationwide list of distributors.

Photographers' Formulary, Inc., P.O. Box 5105, Missoula, Mt. 59806; telephone (406) 543-4534 (10 a.m.-5 p.m. Mountain Time). A very wide range of photographic chemicals, standard and exotic, sold in small and bulk quantities and also in ready-to-mix packets for many formulas; also graduates, Ohaus balances, and a selection of books and pamphlets. Write for catalog and price list. Direct mail and telephone orders. Ships by United Parcel Service.

Zone V, Inc., P.O. Box 811, Brookline, Ma. 02147; telephone (617) 731-3178 (ask for Joe); SOURCE network order, computer address TCC 412. A wide range of photographic chemicals for b&w and color, in small and bulk quantities and in kits; also books and a newsletter. Write for catalog and price list. Direct mail, telephone, and computer network orders. Ships by United Parcel Service.