Basic Chemical Formulae

The bare necessities of a life in the darkroom

Typical Metric Units
(use in photographic formulae)

1 kg = 1,000 g
1 g = 1,000 mg

1 l = 1,000 ml
1 ml = 20 drops

Among the plethora of developers, fixers and toners are an essential few, which will persevere through fashion and commercial profitability. The following is a complete set of basic formulae, which are essential for archival processing. We do not recommend to anyone to prepare their own chemistry as a means of 'saving money', but if you have a hard time obtaining darkroom supplies in your area, or if you like to modify proven formulae in order to obtain unique characteristics, the information presented is a good starting point. To see the whole gamut of darkroom alchemy with all its opportunities and alternatives, get yourself a copy of *The Darkroom Cookbook* by Steve Anchell and *The Film Developing Cookbook* by Anchell and Troop, and add them to your photographic library. These books contain an unrivalled collection of photographic formulae and easy-to-understand explanations on how to use them.

Many chemical suppliers do not sell directly to the public, but there are several suppliers of photographic chemicals around the world selling directly to photographers, including Silverprint in the UK, Artcraft Chemicals, Bostick & Sullivan and The Photographers Formulary in the USA. If you have difficulty finding a qualified local source, start by talking to your neighborhood drugstore or pharmacy. They will be able to either point you into the right direction or may actually sell you most of what you need.

A Note on Safety
As with all other chemicals, there are risks associated with contact, inhalation and ingestion of darkroom chemicals. We strongly advise that you study the material safety data sheet (MSDS) of each chemical before using it. In general, one must always observe the following practices while handling darkroom chemicals.

a. don't smoke in darkroom
b. don't eat or drink in darkroom
c. wear goggles
d. wear an apron
e. wear a face mask
f. wear rubber or latex gloves
g. ensure good ventilation
h. never inhale chemical dust
i. label chemical bottles clearly

Equipment you need to get started:

1. an old fashioned chemical balance or a modern electronic **scale**, accurate to at least ±0.1 grams and weighing up to 100 or 200 grams
2. plastic **syringes** of up to 1, 5 and 10 ml to accurately measure very small liquid volumes
3. a set of **graduated cylinders**, ranging from 30 ml to 1 liter for measuring liquids and solids
4. plastic **scoops** for measuring out chemicals
5. one to three plastic **beakers**, holding 1 and 2 liters each, for mixing working solutions
6. a small and a large plastic **stirring rod** to keep undissolved chemicals in motion
7. plastic **funnels** for pouring liquids into bottles
8. a selection of brown glass or plastic **bottles** to store the solutions and **labels** to identify them

Initial Shopping List for Basic Chemicals

acetic acid *(28%)*	500 ml
ammonium thiosulfate	2 kg
borax *(sodium tetraborate, decahydrate)*	500 g
boric acid *(granular)*	250 g
citric acid	100 g
hydroquinone	250 g
metol	100 g
phenidone	25 g
potassium bromide	100 g
potassium ferricyanide	250 g
potassium iodide	50 g
potassium permanganate	10 g
potassium polysulfide *(liver of sulfur)*	100 g
silver nitrate	5 g
sodium carbonate *(monohydrate)*	1 kg
sodium hexametaphosphate *(Photo Calgon)*	100 g
sodium sulfite *(anhydrous)*	2 kg

Film Developer (D-76 / ID-11)

D-76 is a fine-grain, general-purpose film developer for maximum shadow detail. It was formulated in 1926 by Kodak and still is the standard by which all other developers are judged, because it offers the best compromise between speed, sharpness and resolution. Many deviations from this original formula have been proposed over the years. A recent suggestion is to omit hydroquinone and raise metol to 2.5 g, creating D-76H, an environmentally friendly and more stable developer.

distilled water *50°C / 120°F*	750 ml
metol	2 g
sodium sulfite *anhydrous*	100 g
hydroquinone	5 g
borax *decahydrate*	2 g
cold distilled water to make	1,000 ml

dilute 1+1 for standard film development
use as one-shot developer for processing consistency

Neutral Paper Developer (D-72)

D-72 is a neutral-tone paper developer for brilliant highlights and maximum blacks, very similar to Kodak Dektol. Standard dilution for this developer is 1+2. Dilute 1+1 for longer shelf life and slightly higher Dmax, or 1+3 for warmer tones and softer shadows. It has excellent keeping properties and an outstanding development capacity. Replace with fresh developer as soon as factorial development fails to create potential Dmax. Increase potassium bromide to up to 4 g for warmer tones, similar to Ilford Multigrade or Agfa Neutol NE.

water *50°C / 120°F*	750 ml
metol	3 g
sodium sulfite *anhydrous*	45 g
hydroquinone	12 g
sodium carbonate *monohydrate*	80 g
potassium bromide	2 g
cold water to make	1,000 ml

dilute 1+2 for standard paper development
very similar to Kodak Dektol

Warm-Tone Paper Developer (ID-78)

ID-78 is a warm-tone paper developer with a formulation very close to Ilford Warmtone and Agfa Neutol WA. It works well with all modern neutral and warm-tone papers on the market. Dissolve the phenidone separately in 50 ml of hot water (>80°C). Standard dilution for this developer is 1+3, but it can be used as strong as 1+1 for richer shadows. Replace with fresh developer as soon as factorial development fails to create potential Dmax.

water *50°C / 120°F*	750 ml
sodium sulfite *anhydrous*	50 g
hydroquinone	12 g
phenidone	0.5 g
sodium carbonate *monohydrate*	72 g
potassium bromide	4.5 g
cold water to make	1,000 ml

dilute 1+3 for warm-tone paper development
very similar to Ilford Warmtone and Agfa Neutol WA

Stop Bath (SB-7)

SB-7 is an odorless acid stop bath for film and paper processing. It quickly neutralizes the alkaline developer and brings development to a complete stop. Its capacity is approximately ten rolls of film or 8x10-inch prints per liter. Use prior to acid fixers, and precede alkaline fixers with a plain water rinse instead.

water	750 ml
citric acid	15 g
water to make	1,000 ml

working solution for paper, dilute 1+1 for film

Acid Rapid Fixer (RF-1)

water *50°C / 120°F*	750 ml
ammonium thiosulfate	120 g
sodium sulfite *anhydrous*	12 g
acetic acid *28%*	32 ml
boric acid *granular*	7.5 g
cold water to make	1,000 ml

working solution for film and paper
use two-bath fixing method for film and fiber-base paper
with film, use as one-shot fixer for processing consistency

RF-1 is a non-hardening, acid, rapid fixer for film and paper. The omission of a hardener supports archival washing and makes it easier for spotting fluids to be absorbed by the print emulsion. Dissolve the boric acid separately in 80 ml of hot water (>80°C) and add last, or substitute with 9 g of sodium carbonate to create an almost odorless version of this fixer. We recommend using the two-bath fixing method for film and fiber-base paper, both at full fixer strength. The first fixing-bath capacity is approximately ten 8x10-inch prints per liter.

Alkaline Rapid Fixer (RF-2)

water *50°C / 120°F*	750 ml
ammonium thiosulfate	120 g
sodium sulfite *anhydrous*	15 g
sodium carbonate *monohydrate*	0.7 g
cold water to make	1,000 ml

working solution for film and paper
use two-bath fixing method for film and fiber-base paper
with film, use as one-shot fixer for processing consistency

RF-2 is a non-hardening, alkaline, rapid fixer for film and paper, supporting an odorless darkroom environment and significantly reducing washing times. To conduct an entirely acid-free process, do not use in combination with an acid stop bath. Instead, follow development by a 60s wash in plain water, and use the two-bath fixing method for film and fiber-base paper at full fixer strength. The first fixing-bath capacity is approximately ten 8x10-inch prints per liter.

Hypo-Clearing Agent (HCA-1)

water *50°C / 120°F*	750 ml
sodium sulfite *anhydrous*	100 g
sodium hexametaphosphate *	5 g
cold water to make	1,000 ml

dilute 1+4 for film or paper
** add with hard water supplies to prevent calcium scum*

HCA-1 is a washing aid for film and paper, used subsequent to acid fixers. Treat films for 2 and papers for 10 minutes with slight agitation. Used after a preceding water rinse, the capacity is approximately twenty rolls of film or 8x10-inch prints per liter. With hard water supplies, add sodium hexametaphosphate (Photo Calgon) to prevent the formation of calcium scum on the emulsion surface.

Polysulfide Toner (T-8)

water	750 ml
potassium polysulfide	7.5 g
sodium carbonate *monohydrate*	2.5 g
water to make	1,000 ml

working solution for direct paper toning

T-8 is a direct polysulfide toner for modern papers, similar to Kodak Brown Toner or Agfa Viradon, and can be used at room temperature. Wash fiber-base prints for 30 minutes without washing aid prior to toning. Please note that this toner produces toxic hydrogen sulfide gas, as well as the offensive odor that goes along with it. Only use with adequate ventilation.

Farmer's Reducer (R-4)

At this dilution, R-4 is a proportional reducer for film and paper. Apply with a brush to locally improve print highlights, or treat an entire film to reduce overall negative density. Use solutions in sequence or mix 1+1 just prior to use. Solution A will last for months, but if combined with solution B, the mixture will deteriorate within 10 minutes. Rinse film or paper thoroughly after use. Then, fix again and continue with normal processing.

Solution A

potassium ferricyanide	10 g
water to make	1,000 ml

Solution B

rapid fixer *working solution*	1,000 ml

use solutions in sequence or mix 1+1 just prior to use

Fixer Test Solution (FT-1)

FT-1 is a fixer test solution when archival processing is not required. Add 1 ml to 10 ml of used fixer and stir, and discard the fixing bath if a cloudy, white precipitate forms in the mixture. For archival processing requirements, measure the silver content of the fixing bath with a professional silver estimator.

water	80 ml
potassium iodide	5 g
water to make	100 ml

add 1 ml to 10 ml of used fixer

Residual Hypo Test (HT-1)

HT-1 is a residual hypo test to verify the efficiency of film washing. 1 ml of the test solution is applied to 10 ml of the film's last wash water. The resulting color change of the wash water depends on its thiosulfate content and becomes a rough measure of the emulsion's residual thiosulfate level.

distilled water	80 ml
potassium permanganate	0.1 g
sodium carbonate *monohydrate*	0.2 g
distilled water to make	100 ml

add 1 ml to 10 ml of the film's last wash water

Residual Hypo Test (HT-2)

HT-2 is a residual hypo test to verify the efficiency of print washing. The color stain left by the test solution is an indicator of the hypo level in the paper. HT2 contains light sensitive silver nitrate. Consequently, the entire test must be conducted under subdued tungsten light. Please note that silver nitrate requires 24 hours to completely dissolve.

water	80 ml
acetic acid *28%*	12 ml
silver nitrate	0.8 g
water to make	100 ml

apply a drop to a damp print border for 5 minutes