

# Basic Photo Chemistry

## for the non-chemist

### 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

### 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.

- don't smoke in darkroom
- don't eat or drink in darkroom
- wear goggles
- wear an apron
- wear a face mask
- wear rubber or latex gloves
- ensure good ventilation
- never inhale chemical dust
- label chemical bottles clearly

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.

### Equipment you need to get started:

- an old fashioned chemical balance or a modern electronic **scale**, accurate to at least  $\pm 0.1$  grams and weighing up to 100 or 200 grams
- plastic **syringes** of up to 1, 5 and 10 ml to accurately measure very small liquid volumes
- a set of **graduated cylinders**, ranging from 30 ml to 1 liter for measuring liquids and solids
- plastic **scoops** for measuring out chemicals
- one to three plastic **beakers**, holding 1 and 2 liters each, for mixing working solutions
- a small and a large plastic **stirring rod** to keep undissolved chemicals in motion
- plastic **funnels** for pouring liquids into bottles
- 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 or black salt)	100 g
silver nitrate	5 g
sodium carbonate (monohydrate)	1 kg
sodium hexametaphosphate (Photo Calgon)	100 g
sodium sulfite (anhydrous)	2 kg

**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.

**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.

**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.

**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.

### Film Developer (D-76 / ID-11)

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 Dektol (D-72)

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)

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*

### Odorless Stop Bath (SB-7)

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

*working solution for paper, dilute 1+1 for film*

### Std. Acid Rapid Fixer (SARF-1)

water 50°C / 120°F	750 ml
ammonium thiosulfate	120 g
sodium sulfite <i>anhydrous</i>	12 g
acetic acid 28%	32 ml
boric acid <i>granular</i>	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*

### Alkaline Rapid Fixer (ARF-2)

### Hypo-Clearing Agent (HCA-1)

water 50°C / 120°F	750 ml
sodium sulfite <i>anhydrous</i>	20 g
sodium hexametaphosphate *	1 g
cold water to make	1,000 ml

*working solution for film or paper*

*\* add with hard water supplies to prevent calcium scum*

### Polysulfide Toner (PST-8)

water	750 ml
potassium polysulfide (black salt 20g)	7.5 g
sodium carbonate <i>monohydrate</i>	2.5 g
water to make	1,000 ml

*working solution for direct paper toning*

**SARF-1** is a standard 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.

**ARF-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

**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.

**PST-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. Alternatively, a 2% solution of black Himalayan salt can be used.

**SB-1** is the standard acid stop bath for film and paper processing. It's ideal when used in combination with acetic-acid based fixers. 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.

### Stop Bath (SB-1)

water	750 ml
acetic acid 28%	48 ml
water to make	1,000 ml

*working solution for paper and film processing*

**Rodinal** is a medium-grain, general-purpose film developer for maximum sharpness and acutance. It was formulated in 1880 by Agfa and still is a standard by which all other developers are judged. It is the oldest still commercially available film developer. Many deviations from this original formula have been proposed over the years. It is diluted from 1+25 to 1+100 and has the reputation of having a shelf-life of several decades. **FX37/39** are modern alternatives to Agfa Rodinal.

### Film Developer (Agfa Rodinal)

distilled water 50°C / 120°F	200 ml
sodium sulfite anhydrous	50 g
sodium hydroxide	20 g
paracetamol (Tylenol 30 500mg tablets)	15 g
cold distilled water to make	250 ml

*dilute just like the original Agfa Rodinal from 1:25 to 1:100 use as one-shot developer for processing consistency*

**WA-1** is a wetting agent very similar to Kodak **Photo-Flo**. It reduces water tension, allowing the water to quickly run off the film without leaving ugly water spots. After washing, soak the film in a solution of distilled water and wetting agent for about 1 minute. After hanging, remove excess water by running the film through your fingers.

### Wetting Agent (WA-1)

propylene glycol	25 ml
polyethylene glycol octylphenyl ether*	7.5 ml
water to make	100 ml

*dilute 1+999 for film processing*

*very similar to Kodak Photo-Flo*

*\* also available as 'Triton X-100' and alternatively 'Tween 20'*

**SIS-1** is a silver-image stabilizer with a formulation very close to Agfa **Sistan**. RC or FB prints are treated for 1 minute after archival toning and washing. The stabilizer solution is wiped off, and prints are not to be washed again. The stabilizer remains in the emulsion ready to react with any oxidized silver to prevent discoloration. Silver-image stabilizers are not a replacement for toning but offer additional image protection.

### Silver-Image Stabilizer (SIS-1)

distilled water	750 ml
potassium thiocyanate	95 g
polyethylene glycol octylphenyl ether*	25 ml
distilled water to make	1,000 ml

*dilute 1+19 for paper processing*

*very similar to Agfa Sistan*

*\* also available as 'Triton X-100' and alternatively 'Tween 20'*

**BPH-9** is a buffer and storage solution with a pH value of 9.2 for standard pH meter electrodes. It helps to occasionally recalibrate your pH meter.

### Buffer Solution (BPH-9)

distilled water	50 ml
borax	0.5 g
distilled water to make	100 ml

*calibration solution of pH 9.2*

**LC-1** is a safe lens cleaner, leaving no streak or smudges on eye glasses, camera lenses or similar optics. After cleaning off any loose debris, sand or dust; Spray a small amount on a clean lint-free piece of paper and wipe the lens in a circular motion. Use another piece to wipe off any residue. Never spray any liquid directly on the lens.

### Crawley (FX37/39)

distilled water	50°C / 120°F	250 ml
sodium sulfite (anhydrous)		60g
hydroquinone		5 g
sodium carbonate (anhydrous)		5 g
phenidone		0.5 g
borax		2.5g
potassium bromide		0.5g
cold distilled water to make		1,000 ml

*dilute just like the original Agfa Rodinal from 1:25 to 1:100  
use as one-shot developer for processing consistency*

**SIS-1** is a silver-image stabilizer with a formulation very close to Agfa **Sistan**. RC or FB prints are treated for 1 minute after archival toning and washing. The stabilizer solution is wiped off, and prints are not to be washed again. The stabilizer remains in the emulsion ready to react with any oxidized silver to prevent discoloration. Silver-image stabilizers are not a replacement for toning but offer additional image protection.

**BPH-7** is a buffer and storage solution with a pH value of 7 for standard pH meter electrodes. It prevents the electrodes from drying out and maintains their reference potential.

### Lens Cleaner (LC-1)

windex	10ml
isopropyl alcohol (100%) to make	100 ml

*working solution for paper and film processing*

### Wetting Agent (WA-1)

propylene glycol	25 ml
polyethylene glycol octylphenyl ether*	7.5 ml
water to make	100 ml

*dilute 1+999 for film processing*

*very similar to Kodak Photo-Flo*

*\* also available as 'Triton X-100' and alternatively 'Tween 20'*

### Silver-Image Stabilizer (SIS-1)

distilled water	750 ml
potassium thiocyanate	95 g
polyethylene glycol octylphenyl ether*	25 ml
distilled water to make	1,000 ml

*dilute 1+19 for paper processing*

*very similar to Agfa Sistan*

*\* also available as 'Triton X-100' and alternatively 'Tween 20'*

**SFT-9** is a simplified direct sulfide 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. With FB papers stop toning before fully toned because, toning will continue during the final wash (after-toning).

### Sulfide Toner (Viradonal) SFT-9

water	50°C / 120°F	750 ml
black salt (Kala Namak)		20 g
sodium carbonate monohydrate		2.5 g
cold water to make		1,000 ml

*working solution for direct paper toning tone for 2-8 minutes*

At this dilution, **FR-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.

**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.

**RHT-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.

**RHT-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.

## Farmer's Reducer (FR-4)

### Solution A

potassium ferricyanide	10 g
water to make	1,000 ml

### Solution B

rapid fixer <i>working solution</i>	1,000 ml
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*use solutions in sequence or mix 1+1 just prior to use*

## Fixer Test Solution (FT-1)

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

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*add 1 ml to 10 ml of used fixer*

## Residual Hypo Test (RHT-1)

distilled water	80 ml
potassium permanganate	0.1 g
sodium carbonate <i>monohydrate</i>	0.2 g
distilled water to make	100 ml

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

## Residual Hypo Test (RHT-2)

water	80 ml
acetic acid <i>28%</i>	12 ml
silver nitrate	0.8 g
water to make	100 ml

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*apply a drop to a damp print border for 5 minutes*

**Perceptol** is a medium-grain, general-purpose film developer for maximum sharpness and acutance.

### Ilford Perceptol (Microdol)

distilled water	50°C / 120°F	750 ml
metol		5g
sodium sulfite	anhydrous	100 g
sodium chloride		30 g
cold distilled water to make		1,000 ml

*use undiluted*

*as one-shot developer for processing consistency*

**FDB-1** is based on Hypo Clear but used instead of plain water to dilute film developers from storage to working strength. It reduces film grain and increases film contrast, allowing the film developing time and agitation to remain constant. Adjust film speed(EI) and developer dilution to fit your needs. If possible only use pure sea salt without anti-cumming agents or iodide.

### FilmDevBooster (FDB-1)

water	50°C / 120°F	750 ml
sodium sulfite	anhydrous	20 g
pure sea salt		35 g
sodium hexametaphosphate(FotoCalgon)*		1g
metol		1g
potassium bromide		0.5g
cold water to make		1,000 ml

*working solution to dilute developer with*

*\* add with hard water supplies to prevent calcium scum*

**KodakD23** is a medium-grain, general-purpose film developer for maximum sharpness and acutance and is one of the easiest to make.

### Film Developer Kodak(D23)

distilled water	50°C / 120°F	750 ml
metol		7.5g
sodium sulfite	anhydrous	100 g
cold distilled water to make		1,000 ml

*use undiluted*

*as one-shot developer for processing consistency*

