4-H Photography Skill Guide

Color Printing Techniques

Enlarging Color Negatives

Making your own color prints from color negatives provides a whole new area of photography for you to enjoy. You can make prints nearly any size you want, from small ones to big enlargements. You can crop pictures for the composition that's most pleasing to you. You can control the lightness or darkness of the print, as well as the color balance, and you can experiment with control techniques to achieve just the effect you're looking for. The possibilities for creating beautiful color prints are as great as your own imagination.

You can print color negatives on conventional color printing paper. It's the kind of paper your photofinisher uses. It requires precise processing in two or three chemical solutions and several washes in water. It can be processed in trays or a drum processor.

Drum processor

You must carefully monitor the processing of the color paper. Solution temperatures must be held constant, and length of processing time can't vary from the recommendation. There are four processing steps, not including the final four consecutive 30-second water washes. If the temperature or time strays, you'll find it difficult to produce prints with consistent color balance and density.

Color Relations

Before going ahead into this fascinating subject of color printing, let's make sure we understand some basic photographic color and visual relationships.

1. White light (sunlight or the light from an enlarger lamp) is made up of three primary colors: red, green, and blue. These colors are known as **additive primary colors**. When added together in approximately equal amounts, they produce white light.
2. Color-negative film has a separate light-sensitive layer to correspond with each of these three additive primary colors. Images recorded on these layers appear as **complementary** (opposite) colors.
   - A red subject records on the red-sensitive layer as cyan (blue-green).
   - A green subject records on the green-sensitive layer as magenta (blue-red).
   - A blue subject records on the blue-sensitive layer as yellow.
3. Cyan, magenta, and yellow are called **subtractive primary colors** since each one, when added to its complementary color, can absorb all color to produce black or shades of gray.
4. The interaction of the additive primary colors beamed from an enlarger lamp and the subtractive primary colors in the filters and color-negative layers form the controls necessary in color printing.

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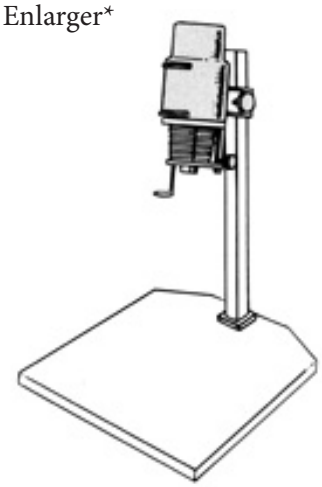
4-H 7743
Reprinted July 2007
$2.00

Things You Need for Color Enlarging

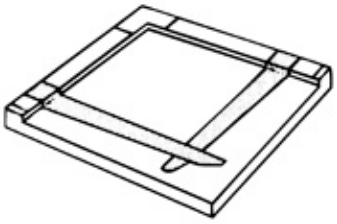
To expose color prints, you'll need the following items:

1. Enlarger*



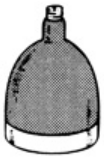
2. Color printing filters

3. Enlarging ease

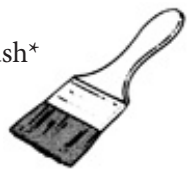


4. Voltage regulator (optional)

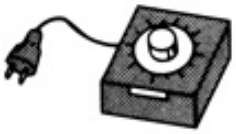
5. Safelight



6. Camel's-hair brush*



7. Enlarger timer*



8. Color printing pape

9. Drum processor or trays for conventional enlarging paper

Enlarging Equipment

You can make color enlargements with almost any enlarger equipped with a tungsten or tungsten-halogen lamp and a heat-absorbing glass in the lamphouse.

No light other than that passing through the negative should reach the enlarger lens. If the area of your negative doesn't quite fill the opening in the negative carrier, mask the negative with black paper or black paper tape. If the enlarger head leaks light, cover it with aluminum foil or other nonflammable material in order to prevent fogging of your color paper.

Be sure your enlarger is equipped with a lens of a focal length compatible with your film size. For example, to enlarge 135-size film successfully, you need an enlarger lens with a 50 mm or longer focal length.

If the enlarger you use for color printing has provisions for putting the required color filters between the lamp and the negative, so much the better. This isn't absolutely necessary but simpler and less expensive, as you'll see shortly.

Another item that is very helpful, although not a necessity, is a voltage regulator. A voltage regulator in the power supply for the enlarger prevents undesirable changes in light output and color quality of the enlarger lamp. If you don't use a voltage regulator, try to avoid exposing your color prints during times when the line voltage is likely to fluctuate; e.g., before mealtimes, when many electric appliances are in use.

*These items are the same as those you need for making black-and-white prints.

Papers

For consistent quality, protect your paper from heat and humidity. Prolonged storage at room temperature will seriously alter the color balance. When you're not using your paper, store it in a refrigerator at 55°F (13°C) or lower. Fold the end of the foil-lined envelope over twice, to help seal out moisture. To prevent moisture condensation on the cold paper, remove it from the refrigerator at least 2 hours before use. Don't open the package until you're ready to begin printing.

When exposing a sheet of paper, the emulsion side should face the enlarger light (emulsion side up). Under safelight illumination, you can determine the emulsion side of the paper. For the color enlarging paper, the emulsion side is darker. Depending on how bright your normal room lights are, you may have to be in the dim safelight environment a minute or two before your eyes adjust well enough to make this visual examination of the paper.

Safelight. You can handle paper for no longer than 3 minutes under a safelight lamp equipped with a safelight filter No. 13 (amber), with a 7½-watt bulb. The paper must be at least 4 feet from the safelight.

Color Filters

Since the color of the print is controlled by placing color filters in the enlarger light beam, you need a set of color filters. Depending on your enlarger design, you may also need a filter to absorb ultraviolet radiation (UV). Enlargers that have a built-in additive (tricolor) filtration system do not require a UV absorber. Their dichroic filters intercept all the light in the lamphouse, efficiently preventing UV radiation exposure on photographic paper.

There are three kinds of color filters for color printing. The kind you use depends on where the filters are placed between the lamp and the negative (**dichroic** or **acetate** filters) or between the enlarger lens and the paper (**gelatin** filters).

It's best, although not absolutely necessary, that the enlarger have a provision for putting the filters into a lamphouse between the lamp and the negative. This is better than putting the filters into the image-forming light below the negative, because there's no limitation to the number of filters you can use above the negative. Some enlargers have dichroic color-printing filters built into the lamphouse. They are usually referred to as **dichroic-head** or **color-head** enlargers. With this kind of enlarger, you can select the necessary combination of filters simply by adjusting the filter controls.

If your enlarger doesn't have the filters built in but accepts filters above the negative, you'll need several color printing filters. **Color printing** filters are identified by the letters **CP**. You should not use CP filters below the negative, because they would adversely affect definition in the print.

Color compensating filters go below the enlarger lens and are identified by the letters **CC**. They are made of gelatin and cost more than CP filters of the same size. Since you can use them in the image-forming beam of the enlarger, be especially careful to handle them only by the edge to keep them clean and free of dust.

The numbers and letters used to identify filters tell you the type, density, and color. For example, in the case of a CP20Y filter, the CP stands for color printing, 20 means the density is 0.20 (to blue light), and Y means the color is yellow.

Here are filters you'll need. If your enlarger accepts filters above the negative, you'll need a selection of color-printing (acetate) filters. With the filters below, you should be able to make any combination necessary for controlling color balance:

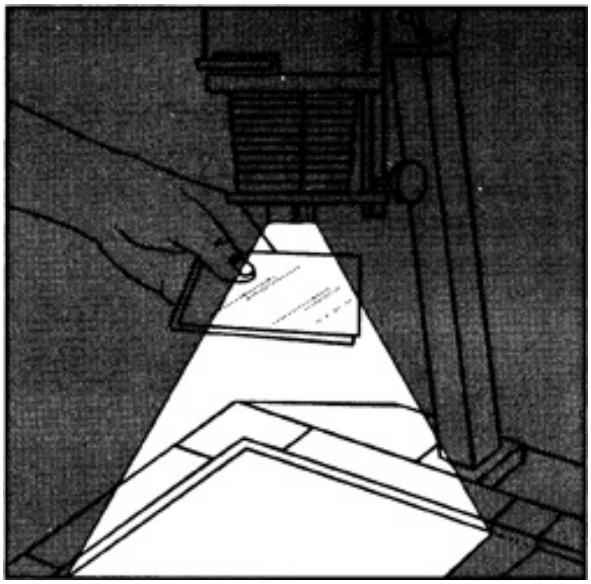
CP2B (always used)		
CP05M	CP05Y	CP40R
CP10M	CP10Y	CP80R
CP20M	CP20Y	
	CP40Y	
	CP80Y	

If your enlarger is constructed so that you must place the filters below the lens, you'll need the following color compensating (gelatin) filters:

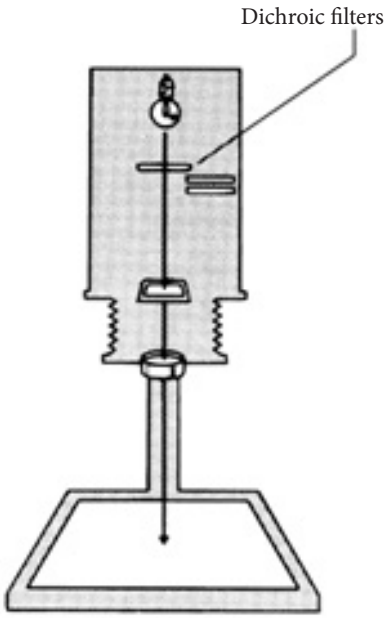
Gelatin No. 2B or CP2B (acetate) installed permanently above the negative (always used)		
CC05R	CC05M	CC05Y
CC10R	CC10M	CC10Y
CC20R	CC20M	CC20Y
CC30R	CC30M	CC30Y
CC40R	CC40M	CC40Y
CC50R	CC50M	CC50Y

You'll need all of these CC filters to obtain the necessary filtration with three or fewer filters in the pack. You should never use more than three filters together below the lens. On the other hand, since you can use any number of filters above the negative, you can achieve all the colors and densities required by using combinations of the CP filters in the first list.

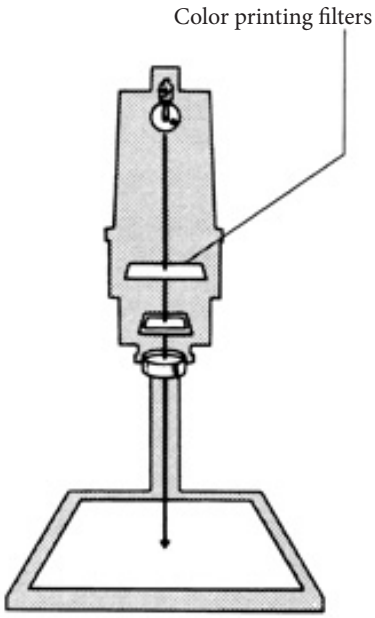
Occasionally, you may need cyan filtration. If so, use either the series CP-2 or CC-2 filters.



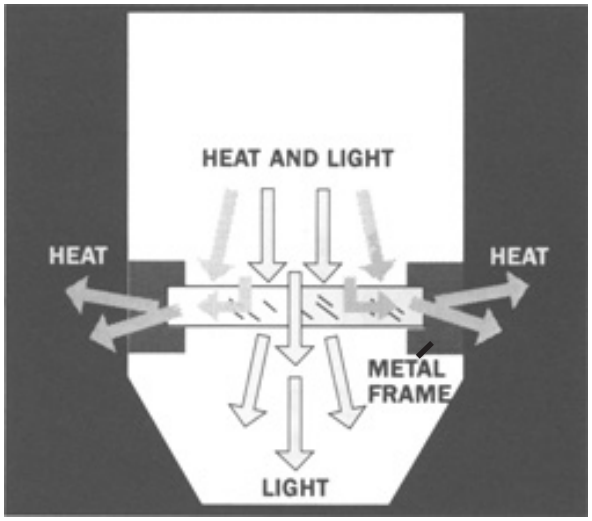
For enlargers lacking built-in filters and a filter drawer, hold color-compensation (CC) filters just beneath the lens during the exposure.



Some enlargers have built-in dichroic filters.



If the enlarger has a filter drawer, insert the correct color printing (CP) filters into the drawer.



Use a heat-absorbing glass in the enlarger lamphouse to protect filters from fading. If you don't have one of these inexpensive items in your enlarger, see your photo dealer.

Color Printing: Step by Step

1. Place a No. 2B or CP2B filter permanently into the enlarger above the negative carrier. If you have a color enlarger, this filter should be built in.
2. Put your dust-free color negative into the enlarger so that the emulsion side (dull side) is toward the enlarger lens. Set the enlarger for the magnification you want.
3. Select a starting filter pack. Make your first test print using a filter pack of 50M + 90Y for the conventional paper and 40M + 40Y for the one-solution paper. Since light quality, optical components, filters, and dial settings may vary considerably among enlargers, this filter pack is only a starting point. If the color balance of the resulting print is not satisfactory, try a different filter or combination of filters. (See steps 6 and 7 below.) Once you've made a good print from a typical negative, you can use the same new filter pack for trial exposures with other negatives.
4. Using the starting filter pack selected, make a test series of four exposures onto one sheet of paper. Make the tests at the same magnification you're going to use for your final print. Expose each section for 10 seconds: one at *f*/5.6, one at *f*/8, one at *f*/11, and one at *f*/16.
5. Process the paper according to instructions packaged with the chemicals. Dry the print, and view it for proper color appearance. When wet, many color papers have a tint, which makes color balance determination practically impossible until a print is dry. However, with a portable hair dryer, you can dry a print in about a minute or two. With conventional color papers, first remove surface water with a squeegee or damp, soft sponge.
6. Judge the best exposure area for proper color. Look at sensitive areas, such as neutrals or flesh tones. Make two decisions: (a) What color is in excess? (b) How much is that color in excess? Slight, considerable, or great?
7. Apply these decisions to Table 1 on page 7. Correct your starting filter pack (if necessary) by adding or subtracting the filtration listed under "Change in Filter Pack." Find the correct exposure time opposite the recommended change. This time is corrected for the new filter pack.
8. As you gain experience, this corrected print will often be a good one. If the print needs further color correction, use Table 2 (page 7). When you use Table 2, increase the exposure time 10 percent for each filter you add, and decrease the exposure time 10 percent for each filter you remove to allow for change in the number of filter surfaces. (No exposure compensation would be necessary if your enlarger has dichroic color printing filters built into the lamphouse, since the number of filter surfaces would not change.)

Make a new print at the *f*-number that gave the proper exposure. If you feel that the best exposure is somewhere between the exposures you used for two of your tests, set the lens opening accordingly.

Example: You exposed the test print using CP filters and an enlarger having a tungsten lamp. The starting filter pack was 50M + 90Y. Exposures on the test print were 10 seconds at *f*/5.6, *f*/8, *f*/11 and *f*/16. The *f*/8 area is best for density. It is slightly cyan. In the TOO CYAN part of the table, "Slight" calls for subtracting 10M and 10Y from your starting filter pack. This gives you 40M + 80Y for your new filter pack. The new exposure is 8 seconds at *f*/8.

Some color-head enlargers have an additive (tricolor) filtration system consisting of three tungsten-halogen lamps in a single head (lamphouse). Each lamp is beamed through a separate, additive dichroic filter—red, green, or blue. Filter control knobs are labeled so that you don't have to think in terms of opposites (complementary colors) when making color-balance adjustments. For example, if you determine that your print is too red, you simply turn the dial marked "RED" to a lower setting. (Actually, the intensity of red filtration increases; but, because the dial works backward, you skip one big mental step and make the adjustment easy.)

f/5.6

f/8

f/16

f/11

You can make a test print like this by starting with a piece of cardboard the same size as your photographic paper. Cut a rectangular notch extending into the center from one corner of the cardboard. Lay this notched cardboard over the paper on the enlarger easel. To expose each corner of the paper, simply rotate or flip over the cardboard between exposures. Use the same exposure time for each section—change only the lens opening.

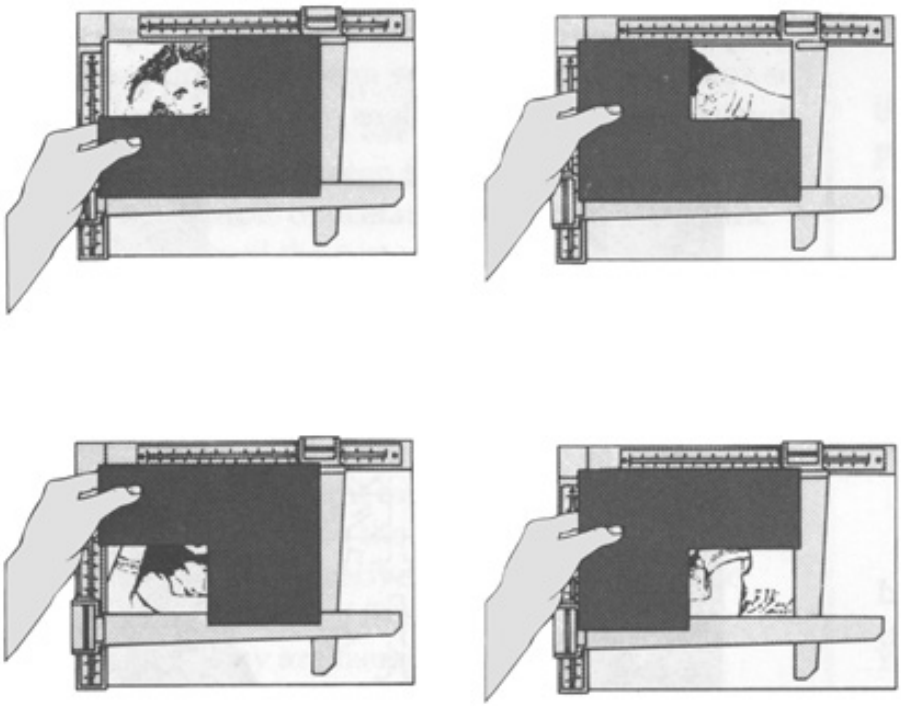


Table 1. Changes in CC or CP Filters and Exposure Time

Amount of color variation from normal		Change in filter	Approximate exposure time (in seconds) for new filter pack*
TOO RED	Slight	Add 10M and 10Y	14
	Considerable	Add 20M and 20Y	17
	Great	Add 30M and 30Y	20
TOO GREEN	Slight	Subtract 10M	8
	Considerable	Subtract 20M	7
	Great	Subtract 30M	6
TOO BLUE	Slight	Subtract 10Y	9
	Considerable	Subtract 20Y	9
	Great	Subtract 30Y	9
TOO CYAN	Slight	Subtract 10M and 10Y	7
	Considerable	Subtract 20M and 20Y	6
	Great	Subtract 30M and 30Y	6
TOO MAGENTA	Slight	Add 10M	13
	Considerable	Add 20M	15
	Great	Add 30M	17
TOO YELLOW	Slight	Add 10Y	11
	Considerable	Add 20Y	11
	Great	Add 30Y	11

*Based on the use of 10 seconds as the original exposure time.

Table 2. Final Change in Filter Pack (if needed)

	Amount of Change Desired		
Appearance of previous print	Very slight	Slight	Considerable
TOO RED	Add 05M and 05Y	Add 10M and 10Y	Add 20M and 20Y
TOO GREEN	Subtract 05M	Subtract 10M	Subtract 20M
TOO BLUE	Subtract 05Y	Subtract 10Y	Subtract 20Y
TOO CYAN	Subtract 05M and 05Y	Subtract 10M and 10Y	Subtract 20M and 20Y
TOO MAGENTA	Add 05M	Add 10M	Add 20M
TOO YELLOW	Add 05Y	Add 10Y	Add 20Y

Exposure Adjustments

Exposure Adjustments for Filter-Pack Changes

You don't have to change exposure time when adjusting dichroic filter settings on color-head enlargers. But with enlargers that use CC or CF filters, you must make allowance for the change in filtering action and the change, if any, in the number of filter surfaces. The following table provides a method to determine such exposure adjustments. The filter factors include allowance for the loss of light caused by reflections from the filter surfaces.

This table is most convenient when you are changing the pack by only one filter. Multiply the original exposure time by the factor for the filter change to get the new exposure time.

Approximate Factors for CC and CP Filters*

Filter	Factor	Filter	Factor
05Y	1.1	05R	1.2
10Y	1.1	10R	1.3
20Y	1.1	20R	1.5
30Y	1.1	30R	1.7
40Y	1.1	40R	1.9
50Y	1.1	50R	2.2
05M	1.2	05G	1.1
10M	1.3	10G	1.2
20M	1.5	20G	1.3
30M	1.7	30G	1.4
40M	1.9	40G	1.5
50M	2.1	50G	1.7
05C	1.1	05B	1.1
10C	1.2	10B	1.3
20C	1.3	20B	1.6
30C	1.4	30B	2.0
40C	1.5	40B	2.4
50C	1.6	50B	2.9

*Check filter manufacturer's recommendations

Exposure Adjustments for Enlarger-Height Changes

As you raise or lower the enlarger to change the image size on the easel, the brightness of that image also changes. For example, as the enlarger goes higher, the projected image gets larger. Because the lamp brightness remains constant, the image becomes dimmer as it grows since the same amount of light must now cover a larger surface area. To compensate for this loss in overall image brightness, you must increase the exposure.

You can use the following formula to determine a new exposure time when changing the enlarger height (easel-to-lens distance):

$$\text{New time} = \text{Old time} \times \frac{\text{New enlarger height}^2}{\text{Old enlarger height}^2}$$

Let's say that on a 4 x 5-inch (10.2 x 12.7 cm) print you are pleased with the exposure of 8 seconds at *f*/11. You now want to make an 8 x 10-inch (20.3 x 25.4 cm) print from the same negative. The distance from the easel to the enlarger was 10 inches (25.4 cm). After raising the enlarger and focusing the lens to produce an 8 x 10 image, you again measure the enlarger height and find that this distance is 20 inches (50.8 cm).

$$\text{New time} = 8 \times \frac{20^2}{10^2}$$

$$\text{New time} = 8 \times \frac{400}{100}$$

New time = 32 seconds (To shorten exposure time, open the lens aperture to *f*/8 for 16 seconds or *f*/5.6 to keep the previous 8-second time.)

Your Standard Negative

A **standard control negative** is a normal negative that has been properly exposed under known conditions and that is known from trial to make an excellent print. As you've printed it previously, you have an accurate record of the filter pack required for your particular equipment and paper emulsion. You can compare this standard negative's printing characteristics with those of other color negatives.

Your standard negative should be typical of the majority of negatives you will be printing. Further, it should be of a typical subject with typical lighting, normally exposed, and normally processed.

Choose for your standard negative an image containing some areas that are relatively sensitive to minor color-balance change. For example, sunsets or flowers are not good test objects, because you can often make pleasing prints of them over a wide range of color balances. However, the face in a portrait is a sensitive area, as is any near-neutral like a concrete surface. Professional photographers often include in the scene a gray scale or a card of 18-percent reflectance, for example the gray side of a neutral test card. Such gray areas will quickly aid you in evaluating even slight color-balance changes.

Most color negatives of the same type of subject exposed under similar conditions will print similarly. Slight differences will result from variations in lighting (time of day, sky condition, etc.), variations in film emulsion, color balance, or variations in film processing. These differences are normal. Just think of these balance variations in terms of filter differences between each negative and your standard negative.

Here's a way to use your standard negative to help you quickly make good prints from other negatives. Each time you begin using a new paper emulsion, first make a normal print from your standard negative and record the filter pack you used. Suppose the filter pack for making a normal print from the standard negative is 40M + 80Y, and the best exposure time is 10 seconds. This filter pack and exposure time become the starting point for similar negatives. You find that a new negative you're printing actually requires adding a 10M filter to the pack, now making the pack 50M + 80Y. You also need to adjust the exposure time to 12 seconds to compensate for differences between the new negative and the standard negative. The new negative prints differently from your standard negative by a 10M filter and a 20 percent increase in time.

Record this information with the new negative. These differences remain constant regardless of the color balance in paper emulsions that you use in the future. For example, you might want to make a reprint of this new negative a year later on a different paper emulsion. The basic filter pack to print your standard negative has become a 20M + 80Y (a difference of –20M) with the paper you're using now. All you'll have to do is increase the exposure by 20 percent and add a 10M filter to this pack to make a normally balanced print without further test. Your adjusted pack for the new negative being reprinted would be 30M + 80Y.

Processing

Solutions

The photographic quality and life of processing solutions depend upon the cleanliness of the equipment in which the solutions are mixed, stored, and used. Avoid contaminating any chemical solution by any other, since this seriously impairs print quality. Take extreme care to avoid contamination of the developer with bleach-fix during mixing and processing, and always keep your equipment clean.

Time and Temperature

When using a conventional enlarging paper, control of the solution temperatures and length of time in the different solutions is very important for maintaining color balance and density in your color prints. Use the temperature recommended by the instructions on the developer package. But whatever temperature you use, carefully maintain it and use the corresponding developing time for that temperature. You need a different developing time for any change in temperature, because the action of the developer slows as the temperature drops. The temperature used for the developer should also be used for the other solutions in the processing cycle.

Processors

Color papers are best processed in drum processors, but they can also be processed in trays.

Drum Processors

Drum processors are light-tight canisters made especially for processing conventional papers. Drum processors are inexpensive both to purchase and to use because they require only minimum volumes of processing solutions.

A typical drum designed for processing 8 x 10 prints requires about 2.4 oz (70 ml) of each chemical solution per print. Actual volumes might vary slightly depending upon the manufacturer, so check your drum instructions for recommended volumes.

In drum processing, a prewet step before the developer step helps prevent streaking and brings the drum and paper up to processing temperature. However, this prewet step dilutes the developer. To compensate, the developer must be specially mixed.

To do this, follow the mixing instructions supplied with a developer. Follow the instructions provided with the drum when you process the paper.

Tray Processing

You can also process color papers in trays. The drawback of trays is that they require considerably more solution than do drum processors. Most processing kits require only two chemicals and a wash, which means three trays should suffice. When mixing chemicals and processing the prints in trays, closely follow the manufacturer's instructions.

Drying

Before drying your prints, use a squeegee or sponge on surfaces to remove excess moisture. Dry the prints in a dust-free place, and do not ferrotype them. Allow for good air circulation by putting them emulsion-side up on towels, on a line using spring clothespins, or on a specially designed drying rack. You can greatly reduce the drying time by blowing hot air onto prints with a portable home hair dryer. Keep the dryer moving so that the hot air is not concentrated in one spot too long. The temperature of the air from the dryer should be below 200°F (92°C).

Printing Color Slides

The same equipment you use for printing color negatives can also be used to print color slides. If you want to make prints directly from slides, you need the appropriate chemicals and enlarging paper made for printing color slides. You can also ask your photo dealer to

make an internegative from your color slide. An **internegative** is made by taking a picture of your slide on negative film. You can use the internegative like any of your other color negatives to make a print. You can use the same color enlarging paper and chemicals you used to make other color prints from negatives. For more information on printing color slides, visit your photo dealer or a library.

By National 4-H Council, 7100 Connecticut Avenue, Chevy Chase, MD 20815, with the cooperation of Eastman Kodak Company, on behalf of the Extension Service, United States Department of Agriculture and the Cooperative Extension Services of the State Land-grant Universities.

This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.

Originally published as PNW 426, October 1992. Reprinted as 4-H 7743, July 2007.