Filters for Forensic Photography

KODAK WRATTEN FILTERS

Optical filters consist mainly of colorants dissolved in gelatin. Most Kodak filters are made by dissolving suitable organic dyes in liquid gelatin and coating the proper amount of the solution onto prepared glass. After the coating is dry, the gelatin film is stripped from the support material. Each gelatin filter is standardized for spectral transmittance and total transmittance by special instruments, which apply an optical form of limit gauge to these characteristics.

The dyes are obtained from a number of sources, and many have been synthesized. Like other dyes, the dyes used in filters may, in time, change under certain conditions of heat and light. Filters, therefore, are not replaced or otherwise warranted against change in transmittance by Kodak.

The most complete line of Kodak filters for photographic uses is available in the form of gelatin films. Prepared in the manner described above, gelatin filters have a thickness of 0.1 mm plus or minus 0.01 mm. Because of their uniform thickness, gelatin filters have excellent optical quality and are suitable for precise work in which little effect on definition and no increase in length of the optical path can be tolerated.

KODAK WRATTEN Filters are supplied as lacquered gelatin form in 75mm, 100mm, and 150mm squares and 350 x 450 mm rectangles. Sizes and shapes may vary due to availability of products and manufacturers change stock.

Any data is based on laboratory testing and intended to be used as a starting point for testing when dealing with critical applications.

Use KODAK WRATTEN Color Conversion Filters when making "significant" changes. Use KODAK WRATTEN Light Balancing Filters when making "minor" changes.

If forced to use KODAK WRATTEN Color Compensating (CC) Filters for light conversion/balancing changes, keep the number of filters to 3 or fewer, if possible. If this is not possible, realize that there may be some loss of image quality to stacking so many filters in front of or behind the lens, even though they are optically pure! Some of the CC conversions offered may require up to 6 filters!

Basic Color Theory

Use the color wheel on the following page as a handy reference tool for many color and black-and-white applications. By knowing how to “manipulate” the colors which form the “Color Wheel”, you can obtain very useful color application information.
**Complementary Colors:**

- Magenta & Green
- Yellow & Blue
- Red & Cyan

**Subtractive Colors:**

- Cyan, Magenta, Yellow

**Additive Colors:**

- Red, Green, and Blue

**Warming Colors:**

- Magenta, Red, Yellow

**Cooling Colors:**

- Blue, Cyan, Green

Use the Color Wheel when possible to combine subtractive filters into additive alternatives, i.e., Magenta + Yellow = Red. With a color film application, for example, and a lighting situation calling for 40M+40Y, you could also substitute 40R. By looking at the wheel, you can see that 40R falls between 40M and 40Y. Any color on the wheel is comprised of equal amounts of the colors to either side.

To locate the complementary color of a specific color, such as Red, look directly opposite Red on the wheel. The complement is Cyan. This can be useful in black-and-white film applications when trying to control color contrast. By using the complementary color filter, you can effectively darken that color on the final print. That's why a yellow filter can be used effectively to darken a blue sky. A filter of the same color will have the opposite (lightening) effect on the final print.

### Filters

<table>
<thead>
<tr>
<th>Kodak #</th>
<th>Color</th>
<th>Effect</th>
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</thead>
<tbody>
<tr>
<td>UV (0)</td>
<td>none</td>
<td>absorbs UV</td>
</tr>
<tr>
<td>0</td>
<td>clear</td>
<td>thickness compensation</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>absorbs UV &lt; 360nm</td>
</tr>
<tr>
<td>1A</td>
<td>pale pink</td>
<td>skylight filter</td>
</tr>
<tr>
<td>1B</td>
<td>light pink</td>
<td>cuts blue cast in shade and distance, absorbs UV</td>
</tr>
</tbody>
</table>

#### Yellows

- 2A pale yellow  UV 405 nm
- 2B pale yellow  absorbs UV 390 nm
- 2E pale yellow  absorbs UV
Inform

ation Compiled and or Written By: Michael J. Brooks

3  light yellow  CCC - corrects outdoor scenes for panchromatic film
4  light yellow  partial correction for outdoors
6  light yellow  full correction outdoors for Type B panchromatic film
9  deep yellow  corrects tungsten light for Type B film
11 yellow-green  minus blue - haze cutting for aerial photography
13 yellow-green  corrects tungsten light for Type C panchromatic film
15 deep yellow  contrast control in aerial IR photography
16 yellow-orange  blue absorption
18A Opaque  transmits UV and IR only

Oranges and Reds

21 orange  blue and blue-green absorption
22 deep orange  yellow-orange (mercury yellow) increase contrast in blue preparations for microscopy
23A light red  contrast effects
24 red  for two-color photography
25 red  for tri-color separation, high contrast effect, aerial IR haze and two-color general viewing
26 red  stereo red
29 deep red  high contrast, tungsten projection of tri-color, red separation in fluorescence process

Magentas and Violets

30 magenta  minus green
31 green  strong green absorption
32 green  blue separation in fluorescence process
35 dark violet

Blues and Blue-greens

38 blue absorption
38A Blue  red absorption, increasing contrast in visual microscopy
39 contrast control in printing motion pictures
40 green  two-color photography
44 light blue-green  minus red, two-color general viewing

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44A light blue-green minus red
45 contrast in microscopy
46 blue projection
47 blue direct color separation, tungsten tri-color projection
47A light blue
47B deep blue tri-color separation form transparencies
48 green and red absorption
48A green and red absorption
49 dark blue
50 very dark blue - mercury violet

Greens

52 light green
53 middle green
54 very dark green
55 stereo green
56 very light green
57 light green green for two-color photography
58 green tri-color green for separations, contrast in photography & microscopy
59 green for tri-color projection
59A very light green
60 green for tungsten two-color photography
61 deep green green tri-color sep, tungsten projection
64 red absorption
65 red absorption
66 contrast effects in microscopy & medical photography
67A red absorption Two-color projection

Narrow band

70 dark red IR photography 676 nm
72B dark or-yellow 605 nm
73 dark yellow-green 575 nm
74 dark green/mercury green 539 nm
75 dark blue-green 488 nm
76 dark violet (compound filter) 449 nm

Hg line filters

77 transmits 546 nm mercury line. glass plus gelatin 580 nm
77A transmits 546 nm mercury line. glass plus gelatin 582 nm
Informations Compiled and or Written By: Michael J. Brooks

Photometrics

<table>
<thead>
<tr>
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<th>Color</th>
<th>Description</th>
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<tbody>
<tr>
<td>78</td>
<td>bluish</td>
<td>photometric filter (visual)</td>
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<tr>
<td>78AA</td>
<td>bluish</td>
<td>photometric filter (visual)</td>
</tr>
<tr>
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<td>photometric filter (visual)</td>
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<tr>
<td>78B</td>
<td>bluish</td>
<td>photometric filter (visual)</td>
</tr>
<tr>
<td>78C</td>
<td>bluish</td>
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<td>86</td>
<td>amber</td>
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<tr>
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Light balancing

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<th>Description</th>
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<tr>
<td>80A</td>
<td>blue</td>
<td>color correction for daylight film (5500) under 3200K (Studio) lamps</td>
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<tr>
<td>80B</td>
<td>blue</td>
<td>color correction for daylight film (5500) under 3400K (Photo) lamps</td>
</tr>
<tr>
<td>80C</td>
<td>blue</td>
<td>color correction for daylight film (5500) under 3800K (clear Flash) lamps</td>
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<td>81</td>
<td>amber</td>
<td>warming -100K</td>
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<tr>
<td>81A</td>
<td>amber</td>
<td>color correction for Type B tungsten film under 3400K (Photo) lamps warming -200K</td>
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<tr>
<td>81B</td>
<td>amber</td>
<td>to remove blue cast in shaded daylight warming -300K</td>
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<tr>
<td>81C</td>
<td>amber</td>
<td>to remove blue cast in cloudy/rainy weather; Kodachrome Type A with flash; warming -400K</td>
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<td>Kodachrome Type A with flash; warming -500K</td>
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<td>81EF</td>
<td>amber</td>
<td>Ektachrome Type B with flash; warming -650K</td>
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<td>blue</td>
<td>cooling +100K</td>
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<tr>
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<td>color correction for Type A tungsten film under 3200K (Studio) lamps cooling +200K</td>
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<td>82B</td>
<td>blue</td>
<td>color correction for Type B tungsten film under 2900K (100w incandescent.) cooling +300K</td>
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<tr>
<td>82C</td>
<td>blue</td>
<td>to remove reddish cast in early morning or late afternoon cooling +400K</td>
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<td>amber</td>
<td>16mm commercial Kodachrome in daylight</td>
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<td>color correction for Type B tungsten film in daylight (5500K-3200K)</td>
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<tr>
<td>85C</td>
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<td>converts 5500K (daylight) to 3800K lighting</td>
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Miscellaneous

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<tr>
<td>X1</td>
<td>green</td>
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**#0** - UV Filter. Absorbs the ultraviolet rays which often makes outdoor photographs hazy and indistinct. A multi-purpose fine-weather filter for color as well as black and white films.

**#1** - UV Filter. Absorbs UV less than 360nm.

**#1A (KR 1.5)** - UV Skylight Filter. Reduces bluish casts in open shade and filters out excessive green from shaded foliage. The filter factor is approximately 1.

**#1B** - UV Skylight Filter. Cuts blue cast in shade and distance, absorbs UV.

**#2A** - UV Filter. Absorbs UV less than 405nm.

**#2B (415)** - Absorbs ultraviolet radiation under clear sky conditions, reducing bluish casts with reversal film and haze with black & white. Absorbs UV less than 390nm. No exposure compensation is required.

**#2C (UV 010)** - UV Filter. Improves color rendition and eliminates unsharpness caused by ultraviolet radiation. The filter reduces distance haze. No exposure compensation is required.
#2E (021, 420) - Light yellow filter accentuates warm, soft, delicate scenes through the enhancement of yellow, orange, and red. It is especially suitable for portraits of women and children, skin tones in natural light, springtime landscapes, and nature scenes. Produces a better separation of green tones, and at long distances reduces haze. Absorbs UV. The filter factor is approximately 1.2.

#3 (Schott CG 455) - Light Yellow Filter. Removes some excess blue in aerial photos. Especially recommended for landscapes when the sun is positioned low. The filter factor is approximately 1.2.

#6, K1, (Schott CG 475) - Yellow filters moderately darken blue sky and shadows illuminated by blue skylight, and lighten foliage.

#8, K2 (022, Schott CG 495) - The #8 filter is frequently considered a correction filter which gives approximately "normal" visual rendering of daylight-illuminated colors with panchromatic films. This medium yellow filter creates subtle differences between green tones and enhances the natural rendition of the sky. It is recommended for landscape and foliage photography. It tones down skin blemishes and reddiness in daylight portraits, and results in soft skin tones as well as intensified blonde hair. Absorbs part of the spectrum between ultraviolet and violet. Makes clouds stand out. Also used for natural rendition of colors in black and white tones. The filter factor is approximately 2.

#9 (023, Schott OG 515) - Deep yellow. More dramatic effect than the #8 filter, further increasing the effects described for the #8 (022) filter. Contrast increases, clouds appear more pronounced, haze is diminished and distance vision is improved. This dark yellow filter distinctly improves reproductions of fine structures such as sand or snow, and increases contrast on foliage. It diminishes skin blemishes and freckles in artificial light. It also darkens eye colors and lightens lip colors. The filter factor is approximately 3.

#11, X1 (060) - A light yellow-green filter which corrects panchromatic film to tungsten eye response. Differentiates green tonal values in landscapes and reduces distant haze. The filter factor is approximately 2.

#12 (099, Schott OG 530) - A yellow filter with correspondingly greater effect than the #6 and #8. The #12 filter is "minus-blue," meaning it absorbs virtually all light of blue wavelengths.

#13, X2 (061) - A yellow-green filter is similar to the #11 filter, but stronger. Yellow green filters darken blue sky values and shadows, as well as red subjects, and lighten foliage somewhat (green filters in general may have less effect on foliage than expected, partly because of the reduced sensitivity of panchromatic films to green.) The #13 filter applies a strong "correction" to panchromatic film under tungsten illumination. A green filter is recommended when using Kodak Tech Pan to photograph scenes which contain foliage. The filter factor is approximately 3.
#15, G - The #15 deep yellow filter absorbs some green light as well as all blue. Used for contrast control in aerial IR photography. Absorbs part of the spectrum between ultraviolet and blue green. Provides stronger contrast than #8, K2, and 022.

#16 (040, Schott CG 550) - Yellow-orange filter darkens blue and violet as well as green and yellow-green. It is indispensable for all landscape and architectural photography which require vivid and clear contours. The sky is distinctly toned with the clouds clearly contrasted against it. This filter is popular for nude photography under natural light. The filter factor is approximately 4.

#18A - Yellow-orange. Transmits UV and IR only.

#21 - Orange. Contrast filter used for blue and blue-green absorption.

#22 (041, Schott OG 570) - Red-orange filter creates a strong darkening of the sky, dramatic storm-like cloud reproduction, and strongly enhanced shadows due to its enhanced contrast. It also achieves good tonal differentiations in still-life photography by brightening yellow, orange, and red. Not suited for portrait photography. The filter factor is approx. 4.

#23A - Red filters tend to darken blue sky and sky-illuminated shadows considerably and produce strong contrast effects; they also darken diffuse reflection from foliage. The #23A is red-orange, but has about the same effect on landscape subjects as the red tricolor #25. Suppresses purple, blue and green. The filter factor is approx. 4.

#24 (090, Schott RG 595) - Red filters tend to darken blue sky and sky-illuminated shadows considerably and produce strong contrast effects; they also darken diffuse reflection from foliage. The #24 (090) is a red tricolor filter that has about the same effect on landscape subjects as the red-orange #23A. The filter factor is approx. 5.

#25 - Red filters tend to darken blue sky and sky-illuminated shadows considerably and produce strong contrast effects; they also darken diffuse reflection from foliage. The #25 is a red tricolor filter that has about the same effect on landscape subjects as the red-orange #23A. Used with #47B and #58 for color separation work. The filter factor is approx. 5.

25A - Absorbs the spectrum between ultraviolet and yellow. Provides the strongest contrast. Makes daylight scenes appear as though photographed at night. Also used for infrared photography.

#26 - Red. For 3-D anaglyph viewing with a #58 green filter.

#29 (091, Schott RG 625) - Red filters tend to darken blue sky and sky-illuminated shadows considerably and produce strong contrast effects; they also darken diffuse reflection from foliage. The #29 (deep, sharp-cutting tricolor red gives maximum contrast with landscape and other situations. Used for color separation and tricolor printing work.
Tricolor projection (tungsten) with #47 (blue) and #61 (green). The filter factor is approx. 8.

#30 - Magenta. Green absorption.

#31 - Magenta. Green absorption.

#32 - Magenta. Minus-green (#12 is minus-blue, #44A is minus-red).

#33 - Magenta. Strong green absorption.

#34A - Violet. For minus-green and plus-blue separation in fluorescence processing.

#35 - Light blue-green. Contrast in microscopy.

#36 - Dark violet.

#38B - Blue. Absorbs red, some UV and green light.

#39 - Blue. Contrast control in printing motion pictures.

#40 - Green. Two-color photography.

#44 - Light blue-green. Minus-red filter with much UV absorption.

#44A - Minus-red (#12 is minus-blue, #32 is minus-green). This filter, used with a panchromatic emulsion, simulates the effect of an orthochromatic film, emphasizing blue and green.

#45 - Blue. Contrast in microscopy.

#46 - Blue. Projection.

#47 - A Blue filter (tricolor) that lightens the sky and darkens green foliage and reds. The use of a blue filter exaggerates atmospheric effects. Used with #29 and 061 for color separation work.

#47A - Light blue. Used for exciting fluorescent dye in medical applications.

#47B - Deep blue tricolor. Used for color separation and tricolor printing. Used with #25 and #58 for color separation work.

#48 - Blue. Green and red absorption.

#48A - Blue. Green and red absorption.
#49 - Dark blue.

#50 - Very dark blue. Mercury violet.

#52 - Light green.

#53 - Medium green.

#54 - Very dark green.

#55 - Green. For 3-D anaglyph viewing with a #25 red filter.

#56 - Very light green.

#57 - Green. For two-color photography

#57A - Light green.

#58 - A strong tricolor green filter that darkens blue sky values and shadows, as well as red subjects, and lightens foliage somewhat (green filters in general may have less effect on foliage than expected, partly because of the reduced sensitivity of panchromatic films to green.) A green filter is recommended when using Kodak Tech Pan to photograph scenes which contain foliage. Used with #25 and #47B for color separation work.

#59 - Green. For tri-color projection.

#59 - Very light green.

#60 - Green. For tungsten two-color photography.

#61 - Deep Green Tricolor. For color separation and tricolor printing. For tricolor projection with #29 and #47.

#64 - Green. Red absorption.

#65 - Green. Red absorption

#66 - Green. For contrast effects in microscopy & medical photography.

#67A - Green. For red absorption, two-color projection.

#70 (Schott RG 665) - Red. IR photography, 676 nm.

#72B - Dark orange-yellow. 605 nm.

#73 - Dark yellow-green. 575 nm.
#74 - Dark green. Mercury green. 539 nm.

#75 - Dark blue-green. 488 nm.

#76 - Dark violet. Compound filter. 449 nm.

#77 - Dark violet. Transmits 546 nm mercury line. Glass plus gelatin. 580 nm.

#77A - Dark violet. Transmits 546 nm mercury line. Glass plus gelatin. 582 nm.

#78 - Bluish. Photometric filter (visual).

#78A - Bluish. Photometric filter (visual).

#78B - Bluish. Photometric filter (visual).

#78C - Bluish. Photometric filter (visual).

#79 - Photographic sensitometry.

#80A (KB 15) - This filter makes possible the use of Daylight film in artificial light with a color temperature of about 3000°K without the color overtones. The filter factor is approx. 2.2.

#80B (KB 12) - This dark blue filter acts as a color conversion filter by converting artificial light of color temperature 3400°K to daylight color film. Without it, strong yellow-orange color tones would occur. The filter factor is approx. 2.

#80C - This filter makes possible the use of Daylight film in artificial light with a color temperature of about 3800°K (clear flash bulbs) without the color overtones.

#81 - Amber. Light balancing filter. Warming -100k.

#81A - Amber. Light balancing filter. Allows Type B daylight color films to be used with 3400°K photo lamps. Warming -200k.

#81B - Amber. Light balancing filter. Eliminates strong blue cast when buildings, trees, etc. are photographed in daylight. Warming -300k.

#81C (KR 3) - Amber. Light balancing filter. Prevents blue cast in cloudy and rainy weather. Especially recommended under cloudless skies. Mountains, seaside or midday sun calls for the use of a #81C (KR 3), since it reduces undesirable bluish casts. Kodachrome Type A with flash. Warming -400k. The filter factor is approximately 1.2.
#81D - Amber. Light balancing filter. Allows Kodachrome Type A color films to be used with flash. Warming -500k.

#81EF - Amber. Light balancing filter. Allows Kodachrome Type B color films to be used with flash. Warming -650k.

#82A (KB 1.5) - Light balancing filter. Allows Type B daylight color films to be used with 3200°K photo lamps. The light blue coloration of the #82A (KB 1.5) filter reduces red casts that can occur when the sun stands close to the horizon. The #82A (KB 1.5) is therefore a counterpart to #85B (KR 1.5). The #82A (KB 1.5) is also useful should you find the color rendition of slide film too warm. The filter factor is approximately 1.1.

#82B - Light balancing filter. Type B tungsten (artificial) color films can be used with 2900°K illumination.

#82C (KB 3) - Light balancing filter. Used to convert 5500°K lighting to 3800°K. The filter factor is approximately 1.2.

#83 - Amber. Allows use of 16mm commercial Kodachrome in daylight.

#85 (KR 12) - Light balancing filter. Type A tungsten (artificial light) color films can be used in daylight or with an electronic flash. The filter is brown and eliminates the overall blue cast. The filter factor is approximately 2.

#85B (KR 15) - Light balancing filter. Type B tungsten (artificial light) color films can be used in conditions such as mountains where even daylight film would require a KR 3 or a #6 filter. The filter factor is approximately 2.3.

#85C - Amber. Converts 5500K (daylight) to 3800K lighting.

#87 (Schott RG 780) - Visibly Opaque infrared filter. Transmits IR light greater than 770nm.

#87A, RM90 (094, Schott RG 1000) - This black infrared filter will filter out the entire visible spectrum. It is useful with black and white infrared films with a sensitivity from 1000 to 1200 nm. The filter factor is determined by the film sensitivity.

#87C (093, Schott RG 830) - This visibly opaque infrared filter will filter out the entire visible spectrum. It is useful with black and white infrared films with a sensitivity up to 1000 nm. Transmits IR light greater than 830 nm. The filter factor is determined by the film sensitivity.

#88A - This infrared filter transmits IR light greater than 770 nm.

#89B, R72 (092, Schott RG 695) - Visibly Opaque used for infrared photography, especially aerial. Transmits wavelengths greater than 700 nm. This Dark red filter is for
black and white infrared film and filters out light below approximately 650 nm. It allows
tables of a pure read image while making good use of relatively low sensitivity of
infrared films. The filter factor is approximately 20-40.

#90 - Dark grayish amber. Monochrome viewing filter. Visually approximates the
relative tones of gray produced in black-and-white prints by different colors under
daylight illumination. 10% luminous transmittance.

#96 - Dark grayish amber. Neutral filter for controlling luminance. 9% luminous
transmittance.

#97 - This filter is used for dichroic absorption.

#98 - Blue. Equivalent to #47B plus #2B.

#99 - Green. Equivalent to 61 plus #16.

#102 - Yellow-green. Converts barrier-layer photocell response to eye luminosity
response.

#106 - Amber. Converts an S-4 type photocell response to eye luminosity response.

ND-1 (101) - This light tinted filter reduces light transmission when there is too much
light while using high-speed film. The filter factor is 2.

ND-2 (102) - By using this filter, it is possible to use the relatively longer shutter speeds
while retaining a wide aperture even in bright illumination. This allows for the emphasis
of the subject by controlling depth of field or creating motion effect with subject blur.
The filter factor is 4.

ND-3 (103) - This filter is denser than 102 and more light absorbing. It is suited for
video, especially when a small enough lens opening is not available. In addition, a
specific depth of field limit can be obtained. The filter factor is 8.

ND-6 (106) - This filter is especially useful when making extremely long exposures
(several minutes). It is also suited for video. The filter factor is 64.

ND-10 (110) - This filter is useful for the observation and documentation of industrial
processes at high temperatures and light levels. This type of filter prevents strong flare
and brings out interesting details. the filter factor is 1000.

ND-13 (113) - This filter belongs in the realm of industrial processes and lunar
astrophotography. Due to its high density, it allows for the long exposures which are
necessary. The filter factor is 10,000.
**ND-20 (120)** - This filter is especially made for observation and photography of the sun. Be cautioned, however, that direct observation of the sun through any filter is to be strictly avoided since long wavelength infrared radiation, which is harmful to the eye, is not blocked. The filter factor is 1,000,000.

**484** - Violet. This deep violet filter transmits only ultraviolet light almost without reduction. It is used in fluorescent photography in front of the light source. In addition, it can be used for black-and-white photography for the enhancement of haze and fog. The filter factor is approximately 10.

**KB 20** - Depending on the percentage of red, conventional household bulbs require extreme color temperature conversion whenever daylight color film is being used indoors. The filter factor is approximately 2.7.

**FL-Day (499)** - Eliminates green cast when daylight type films are used under daylight type fluorescent lights. The filter factor is approximately 2.

**FL-W** - Eliminates green cast when daylight type films are used under white fluorescent lights.

**X0** - Transmits green and absorbs part of the spectrum between ultraviolet and blue. Natural rendition of skin and lips of female models. Highly effective for outdoor portraits.

### Brand Equivalent Filters

| Tiffen (Wratten) 18A | = Schott UG-1, Hoya U-360, B+W 403, Peca 900 |
| Tiffen (Wratten) 70 | = Schott RG665, Hoya – none, B+W none, Peca 902 |
| Tiffen (Wratten) 87 | = Schott RG780, Hoya – none, B+W none, Peca 904 |
| Tiffen (Wratten) 87A | = Schott RG1000, Hoya RM-100, B+W none, Peca 906 |
| Tiffen (Wratten) 87B | = Schott RG1000, Hoya RM-100, B+W none, Peca 908 |
| Tiffen (Wratten) 87C | = Schott RG850, Hoya IR – 85, B+W 093, Peca 910 |
| Tiffen (Wratten) 88A | = Schott - none, Hoya – none, B+W none, Peca 912 |
| Tiffen (Wratten) 89B | = Schott RG715, Hoya R-72, B+W 092, Peca 914 |

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For a comprehensive list of filters and their attributes, please refer to the table below:

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<th>Wratten Rating</th>
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<th>50% Transmission (nm)</th>
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B+W Infrared Filter 092 (89 B) [RG 695]

The nearly opaque Infrared Filter 092, which looks dark purplish red when held in front of a light source, blocks visible light up to 650 nm, and passes only 50% of the radiation just below 700 nm (thus the dark red color). From 730 nm to 2000 nm, transmission is greater than 90%. This makes photographs of pure red and infrared images possible making the best use of the relatively low sensitivity of infrared films. As the sensitization of infrared black-and-white films barely extends beyond 1000 nm, the red portion that is transmitted still makes a relevant contribution to the exposure. This makes the 092 the preferred filter for pictorial photography on IR black-and-white film. Its filter factor is 20 to 40.

B+W Infrared Filter 093 (87 C) [RG 830]

This Infrared Filter blocks the entire visible spectrum, so to our eyes it looks completely opaque. Unlike the 092 infrared filter described above, it makes pure infrared photographs possible without any residual visible red component. Its transmission only begins to exceed 1% at 800 nm, rising to 88% at 900 nm, and remains that high far beyond the upper limit of sensitization covered by infrared films. This filter is used less frequently in pictorial photography because of the dramatic loss of effective ISO. But in the scientific field, materials research and forensics, transmission strictly limited to the infrared range is often important. The filter factor is somewhat dependent on the illumination and on the characteristics of the film.

Hoya Infrared Filters

Used for photography with infrared films. Infrared film is also sensitive to ultraviolet rays and the shorter wavelengths of the visible spectrum so it is necessary to filter out all but the infrared rays. R72 passes only infrared rays above 720nm; RM90 passes only that above 900nm. Often used in crime detection, medical photography, detection of distribution of vegetation, etc.

In ordinary photography with infrared film or infrared color film, the Y(K2), O(G), R(25A) and other filters can also be used to change the contrast or color effect.

Spectral Graphs & Transmission Percentages

18A

18A Visibly opaque glass filter. Transmits only ultraviolet radiation between about 300 and 400 nm (e.g., 365 nm line of mercury spectrum) and infrared radiation. Isolates UV for ultraviolet reflection photography.

Kodak “Wratten” Filter
70 Dark Red. Narrow-band monochromat for making separation positives from color negative films. Also for three-color printing on color papers.

Kodak “Wratten” Filters
## Filters for Infrared Photography

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**NOTE:** Colorimetric values for the filters listed in the above tabulation are not given, since predominant transmission is outside the visible region.

**Kodak “Wratten” Filters**
Ultraviolet & Infrared Photography

Forensic Photography involves many techniques, cameras, lenses, films, chemicals and printing paper.

Some of the techniques used in Forensic Photography are standard in nature having been used over the last 100 years by law enforcement, while some can be highly experimental.

The lighting techniques that can be used are vast. To name a few: Side lighting, Transmitted lighting, Reflected lighting, Diffused lighting, Back lighting, Axial lighting, Infrared Luminescence, Ultraviolet Fluorescence, Reflected Ultraviolet, as well as many other techniques that are only limited by your imagination.

Equipment and supplies present even more questions and benefits. There are silver-based film cameras, lenses and their accessories. Now we have digital cameras, lenses and their accessories. In conjunction with alternate light sources such as the ones that control the Electromagnetic Spectrum, we can use contrast control filters, excitation filters, and barrier filters.

Last but not least, we can use a wide range of films, chemicals, photographic papers and processes to enhance, or help develop, material or latent evidence that can assist in the resolution of a particular case under investigation.

These are but some of the techniques, equipment, supplies and processes that can be used. Once you have a firm grasp on the basics of photography the more advanced processes will be much easier to learn and experimentation will become routine.

Luminescence

When any object is illuminated with short-wave radiation longer wavelengths of radiation will be reflected from that object. This phenomenon is known as excitation. More often than not this reaction can be seen
within the visible spectrum. There are two distinct types of luminescence, fluorescence and phosphorescence. Using gamma rays, X-rays, ultraviolet radiation and some wavelengths of the visible spectrum can create luminescence.

**Fluorescence**

If luminescence is halted within a short period of time by removing the excitation radiation, than fluorescence will occur. Fluorescence is commonly produced by UV radiation. However, other radiations can create fluorescence including some wavelengths of the visible spectrum. Contrasts between the elements of a substance or material that may appear similar can be determined different by means of fluorescence.

**Phosphorescence**

Long after fluorescence ceases by removing the excitation radiation, there are some substances that luminesce long after the excitation has halted. Phosphor compounds cause a phenomenon called phosphorescence. Phosphors in a television, for instance, cause phosphorescence.

**Infrared Luminescence**

Most luminescence falls in the visible spectrum. Several types of radiation can cause the excitement in the specimen. For example, the excitement may be caused by ultraviolet, visible blue wavelengths or luminescence in the infrared range by blue-green irradiation.

**Ultraviolet**

Light that is visible to the human eye in the Electromagnetic Spectrum (EMS) falls between 400 to 700 nanometers. This is the radiation spectrum used in normal photography.

There is another band of radiation that also falls in the EMS; these energies are known as ultraviolet (UV) radiation. Ultraviolet light is divided in three bands: Long wave UV that extends from 320 to 400 nanometers. Medium wave UV that extends from 280 to 320 nanometers. Short wave UV that extends from 200 to 280 nanometers.

The reason we use ultraviolet radiation in photography is to obtain information that can’t be gathered from the visible spectrum. Ultraviolet photography is normally done with reflected ultraviolet radiation with the premise that at least two elements or more of an object to be photographed will reflect or absorb ultraviolet radiation differently. Some items to be photographed absorb UV radiation while others reflect UV radiation.

Photographic film emulsions are sensitive to UV radiation even though ultraviolet radiation is “invisible” to the naked eye. However, visible light needs to be “blocked” from the film emulsion by use of a filter in order to see the effects of ultraviolet radiation with photographic film.

There are many sources of ultraviolet radiation (Illumination), the most common source being the sun. Other sources of ultraviolet radiation are; Fluorescent Tubes, Mercury Vapor Lamps, Arc Lamps, Electronic Flash Lamps and Wire Filled Flash Lamps.

Whatever the source of illumination, a filter must be used when performing ultraviolet photography. The filter must have the ability to transmit ultraviolet radiation and block all visible light. The Kodak Wratten 18A filter will transmit a high level of ultraviolet radiation. When using the 18A filter all visible light must blocked out in order to achieve the full effect of the ultraviolet radiation. However, when using the 18A filter a strong light source must be used as well. For example when using an 18A filter electronic flash or high intensity continuous light sources are used. Exposure times can be reduced when using an 18A filter by selecting film of high ISO, i.e., ISO 400 or ISO 3200.
When using UV fluorescent tubes (known as “Black Lights”) as a source of illumination, a series Kodak 2A filter should be used over the lens in conjunction with a medium to fast ISO film. Other filters in the Kodak 2 series can be used to pass varying degrees of ultraviolet radiation.

The film to be used can be any type of black and white film. Color film has no advantage in ultraviolet photography and is actually a hindrance in that the film cannot see the effects of the ultraviolet radiation. Ultraviolet radiation normally presents an image of low contrast, so a medium contrast film with a high contrast developer.

**Infrared**

Another type of energy that affects photography is an energy that is found beyond the visible spectrum, this energy is known as Infrared (IR) energy.

Normally, infrared wavelengths are found beyond 700 nanometers, however, near infrared wavelengths can be found just inside the visible spectrum.

The greater percentage of the human population cannot see IR energy. Fortunately, some imaging systems and media (films) can record invisible energies, such as infrared and ultraviolet. Infrared, which has been established at this point is an invisible energy, it's an energy that starts at about 700 nanometers (millimicrons) and continues out to approximately 20,000 nanometers.

Infrared wavelengths that can be used in photography do, however, start in the near visible spectrum (700nm) and continue out to 1350nm. Realistically, most infrared energy recorded by photographic means fall in the wavelengths between 700 and 900 nanometers.

Where is the infrared energy we record in photography?

Incandescent objects such as the sun or light bulbs cause the actinic range, which is infrared radiation nearest visible light. Normally, actinic radiation is produced by objects that don’t produce heat. This convention goes against the principles of incandescent lighting.

Other ranges of infrared radiation are the hot-object range produced by hot-irons and electrical appliances. Next in line is the colorific range and the fourth range of infrared radiation is the warm range produced by the human body or by soil.

**Infrared Reflected Photography**

When using readily available light sources (incandescent or electronic flash) or natural light such as the sun, reflected infrared radiation can be recorded by films or digital cameras and can be enhanced greatly by using any one in a series barrier filters.

With infrared photography, barrier filters block "visible light" but allow reflected infrared energy [from our subject] to pass through the filter in order to record the reflected infrared energy by means of photography.

By placing an 18a (the 18a is both a UV & IR passing filter), 70, 87, 87A 87B, 87C, 88A or 89B filter over the lens, varying degrees of infrared reflectance can be recorded on film or within a digital camera that is able to record infrared energy.

The methods for recording infrared energies in photography include infrared sensitive films such as Kodak’s High Speed Infrared film or a digital camera that has the ability to record infrared energy.
When using a digital camera for infrared reflected, one will need to use a digital camera that has had the hot-mirror removed at the factory or in after market modifications in order for a digital camera to have the ability to record Infrared energy. Most (99% or more) of the digital cameras manufactured come from the factor with a hot-mirror installed over the sensor chip which blocks infrared (and ultraviolet) energy so as to not affect traditional daylight photography.

As a sidebar, panchromatic B&W film can be used for infrared photography; however, because these films are not very sensitive to infrared your exposure times will be enormously long. With panchromatic films exposure times of one hour or more is common when using panchromatic films with IR energy and infrared band pass filters.

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Photo Net: www.Photonet.com
Kodak: www.Kodak.com
Jacks Photographic & Chemistry Site: www.jackspcs.com/filters.htm
CoCam Website: www.cocam.net/CoCamWS/Infrared/INFRARED.HTM
Hoya Optics: http://www.hoyaoptics.com/color_filter/index.htm
Hoya Filters: http://www.hoyafilter.com/
Newport Industrial Glass, Inc.: http://www.newportglass.com/kopp.htm

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