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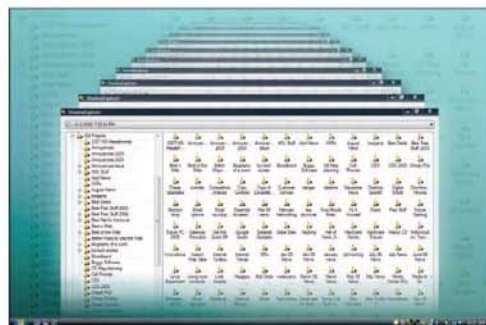


Long Lenses, Low Prices: The Top Megazooms p.101

Exclusive Tests: Cheap vs. Pricey Printer Ink p.92



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CHEAP



INK:

Will It Cost You?

Buying replacement ink from a third-party vendor can save you big bucks. But will you pay with lousy-looking prints that fade in no time? We did months of testing to see how well cheapo replacement inks compare with the manufacturers' own brands.

BY JEFF BERTOLUCCI • ILLUSTRATION BY GEOFF SPEAR

RAZOR-BLADE MAKERS sell consumers the shaver at low prices and then make a killing selling replacement blades. Printer manufacturers do the same thing—selling their printers on the cheap and then making bank on expensive consumables like ink. It's a time-tested practice that's inspired a lively after-market of cheap ink from third-party suppliers.

The printer makers—the original equipment manufacturers, or OEMs—claim that their ink is worth the premium prices they charge for it. OEM ink, they say, creates images that are more accurate and color-rich, and longer-lived. Third-party suppliers, on the other hand, say that their inks are just as good but >>



cost a lot less. For example, HP charges \$18 for a black ink cartridge for the Photosmart C5180, but the same cartridge remanufactured by Cartridge World costs only \$8.75.

Who's telling the truth? To find out, *PC World* teamed up with the Rochester Institute of Technology, a respected research university known for its top-notch laboratory for testing imaging products. Using popular ink jet printers from Canon, Epson, Hewlett-Packard, Kodak, and Lexmark, we ran side-by-side tests of brand-name and third-party inks to compare image quality and fade resistance. We also tracked how many pages each cartridge churned out before running dry.

Our tests show that all of the third-party inks in our test group yielded more prints per cartridge—on top of costing less—but that, with some notable exceptions, the printer manufacturers' ink we evaluated usually produced better-quality prints and proved more resistant to fading. Of course, our conclusions apply only to the printers we tested. We couldn't test all of the printers that are available (partly because you can't get third-party ink for all of them), so we picked a set of mainstream inkjet printers from recognized brands as a way of taking a snapshot view of the ink market.

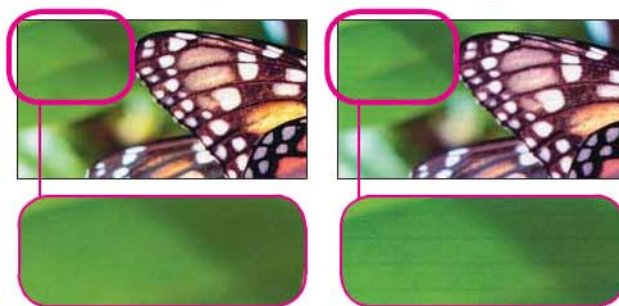
Manufacturers' Inks Made Higher-Quality Prints

WE USED DIFFERENT inks to print various images on plain and photo paper, and then compared the quality of the prints. With one exception (HP vs. third-party inks), images made with manufacturers' inks were more accurate and more color-rich.

PRINTER	Ink	Text and line art	Photos (color and black-and-white)	Overall
Canon Pixma MP830	Canon CLI-8	Good	Very Good	Very Good
	TrueStar	Fair	Good	Good
Epson Stylus CX5000	Epson No. 69	Fair	Good	Good
	LD Products	Fair	Fair	Fair
HP Photosmart C5180	HP 02	Good	Good	Good
	Cartridge World	Good	Good	Good
	LD Products	Good	Good	Good
Lexmark X3470	Lexmark No. 1	Fair	Very Good	Good
	Cartridge World	Fair	Fair	Fair
	Overstock.com	Poor	Fair	Fair
	Walgreens	Poor	Fair	Fair
Kodak Easyshare 5300 ¹	Kodak 1963149	Good	Good	Good

HOW WE TEST: We used five test printers to print a series of text, line art, grayscale, and color photo images on plain or photo paper. For photo prints we used the paper that the printer's manufacturer recommended for optimal results across all ink types. A panel of three judges, using guidelines developed by the PC World Test Center, graded the test prints as Poor, Fair, Good, Very Good, or Superior. The overall rating is an average of seven image quality scores awarded to test images created using that ink. FOOTNOTE: ¹No aftermarket ink for the Kodak 5300 was available at the time of our testing. Source: PC World Test Center.

Close-Up: Ink Quality Test



GOOD QUALITY

In a Canon printer, Canon brand ink accurately re-created the gradual hues of the test image.

NOT-SO-GOOD QUALITY

In the same printer, TrueStar ink created abrupt changes (called banding) between color shades.

The Image Quality Face-Off

The PC World Test Center created a number of different text and image printouts, pitting manufacturers' inks against third-party inks in five different printers. Image samples included a motion shot of cars on a racetrack, a close-up of a butterfly, a photo of a group of people with different skin tones, and a black-and-white photo of a boat. For text we created Word document samples on plain paper; for line art we designed a test document with closely grouped vertical and horizontal lines. Judges then rated the pages for qualities such as color accuracy and vibrancy, sharpness of text and of line art, and contrast levels in grayscale images.

In most matchups, brand-name inks outperformed third-party alternatives, but there were a few instances in which third-party inks fared just as well as the brand-name inks did. For example, in evaluations of output from the HP Photosmart C5180 printer, inks from third-party challengers Cartridge World and LD Products earned scores identical to those awarded to HP's own ink, including an overall rating of Good, on almost all of our tests. Both the HP and the third-party inks printed color glossies quite well but were just so-so at producing color images on plain paper.

However, after RIT technicians submitted their fade and yield results—and returned the printers it had tested to us—they became concerned that some of the HP-brand ink might have remained in the HP 5180 printer when it was printing test images using third-party ink, because the printer has unusual, long ink tubes that connect the cartridges with the printer nozzles. RIT therefore recommended that we omit the HP and HP-compatible inks from the fade test results.

We subsequently conducted our own tests to determine how much ink could have remained in the HP printer's tubes. To do so, we swapped the cyan and magenta inks (in a set of aftermarket cartridges) and printed a color composition. The image quality changed dramatically with the eighth print, indicating that the swapped ink had flushed the HP ink; if any

difference in image quality were to occur, it would have to happen after the machine had printed eight pages. We then printed 20 pages from each set of cartridges—HP’s ink and three aftermarket inks—and saw no change in print quality, a result tending to support our earlier conclusion that the print quality of the third-party ink was equal to that of the HP ink.

In output from an Epson CX5000 printer, Epson’s and LD Products’ inks performed well overall, though the Epson ink scored higher for its color glossies and grayscale prints. Our judges didn’t care for the line-art output from either vendor’s ink, however; one judge commented: “Blech! Lots of overlapping lines. Horrible diagonals—jagged and feathery.”

Tested in a Pixma MP830 printer, Canon ink produced samples that looked particularly sharp in our plain text, color glossy, and grayscale print tests. A third-party competitor, TrueStar, was no slouch either, receiving an overall score of Good. The TrueStar ink excelled at color glossies, but fell far short of Canon ink at printing on plain paper, whether the content consisted of color images, grayscale images, or text.

Lexmark’s house brand earned a Good overall score, and its color glossy output snagged the only Superior rating our judges awarded. Meanwhile, the inks from Cartridge World, Overstock.com, and Walgreens earned lower marks overall: For color glossies, the third-party inks earned scores of Good or Very Good (below the ratings for Lexmark’s own ink), and their grayscale output received a grade of Poor. Our panel criticized the third-party inks for banding (abrupt changes between shades of the same color) and for odd, greenish hues.

Third-Party Ink Yields Were Higher

On the other hand, printing with the third-party cartridges in our tests will save you anywhere from 3 percent to nearly 70 percent per page, depending on what kind of printing you’re doing. For example, a set of remanufactured Epson Stylus CX5000 color cartridges (cyan, magenta, and yellow) from 123Inkjets.com printed nearly 70 percent more pages than the Epson ink, at a cost of about 9 cents per page of color printing, and 2.6 cents per page for black. In contrast, Epson’s ink cost 30 cents per page of color printing and about 10 cents per page for black. Epson’s Web site says that a set of its color cartridges for the CX5000 should print about 350 pages, but the Epson cartridges we tested averaged only about 190 pages. In contrast 123Inkjets’ remanufactured color cartridges averaged just over 320 pages.

Third-party ink cartridges outlasted HP ink cartridges by an even greater margin. 123Inkjets’ black cartridge for the HP Photosmart C5180 printed at a cost-per-page of 0.6 cent, while its brand-name HP counterpart printed at 2.2 cents per page. The 123Inkjets cartridge yielded 72 percent more pages than the HP before needing replacement. 123Inkjet’s color cartridges (cyan, magenta, and yellow) did even better, yielding an average of 99 percent more pages than the HP cartridges. Cartridge World cartridges, which cost less than HP’s

Third-Party Inks Printed More, Cost Less

WHICH PRINTER INKS—those made by printer manufacturers or those made by third-party ink sellers—delivered more bang for the buck? Using 13 competing cartridges in five printers, we calculated the cost of the ink needed to print a page of black-only, full-color, or high-quality photo printing. Though many third-party ink cartridges failed to work in our test printers, those that did printed more pages and cost substantially less than the brand-name rivals. See our charts on pages 94 and 96 for the rest of the story.

PRINTER	Ink	Black-only printing ¹	Color printing ²	Photo printing ³
Canon Pixma MP830	Canon CLI-8	3.6 cents	11 cents	26 cents
	Cartridge World	2.6 cents	7 cents	17 cents
Epson Stylus CX5000	Epson No. 69	9.6 cents	30 cents	59 cents
	123Inkjets	2.6 cents	9 cents	16 cents
	Cartridge World	n/a ³	n/a ³	n/a ³
HP Photosmart C5180	HP 02	2.2 cents	9 cents	32 cents
	123Inkjets	0.6 cents	3 cents	11 cents
	Cartridge World	1.3 cents	6 cents	17 cents
Lexmark X3470	Lexmark No. 1	16 cents ⁴	16 cents	30 cents
	Walgreens	n/a ⁵	15 cents	29 cents
	Overstock.com	10 cents ⁴	10 cents	n/a ⁶
	Cartridge World	7 cents ⁴	7 cents	n/a ⁶
Kodak Easyshare 5300 ⁷	Kodak 1963149	2 cents	8 cents	12 cents

HOW WE TEST: All printers were evaluated following ASTM International testing standard F2555-06 “Standard Practice for Determining Page Yield of Ink Jet Printer Cartridges—Continuous Printing Method.” Using an ASTM F1942 text document with 5 percent area coverage (all colors) as our definition of a printed page, we report the average page yield of three cartridge sets. n/a = Not available. FOOTNOTES: ¹Black-only ink cost per page is derived by dividing the cost of one black cartridge by the number of pages it yielded. ²Color and photo printing ink costs per page are derived by dividing the cost of all ink colors (including black, whether in separate cartridges or all-in-one) by their average page yield. ³Cartridges failed to print when installed. ⁴Black ink and color inks (here contained within one cartridge) ran out simultaneously at the end of the test. ⁵The all-inks-in-one cartridge failed before the black ink ran out. ⁶Cartridges failed early with major print-quality defects (see “Brand-Name Cartridges Were More Reliable,” page 97, for details). ⁷No aftermarket ink for the Kodak 5300 was available at the time of our testing. Source: Rochester Institute of Technology; ink prices from PC World research.

OEM versions on all counts, produced impressive page yield numbers, too: Its black, cyan, and magenta cartridges generated about 70 percent more pages than the HP cartridges, and its yellow cartridge churned out 80 percent more.

The overall disparity between Canon inks and Cartridge World inks was smaller. Both cartridge sets produced reasonably good page yields and costs per page for black and color prints. For high-quality photo prints, however, the Car- >>

tridge World cartridges were a bargain, printing at 17 cents per page versus the Canon inks' 26 cents per page. (For details see "Third-Party Inks Printed More, Cost Less" on page 95.)

Manufacturers' Inks Aged Gracefully

Several factors determine how well a color print withstands the effects of aging. Heat, light, and pollution play major roles, as do the inks' chemical composition and the type of paper they're printed on. To test the inks' resistance to these sources of image fading, RIT technicians placed print samples in an image-durability chamber, which speeds up the aging process by exposing the prints to concentrated levels of ozone and ultraviolet light (see "How We Tested the Longevity of Inks" on page 97). In the end all of the inks tested suffered some loss of optical density, but the OEM inks generally resisted fading better than their third-party competitors did.

In RIT's study, Epson's inks, on average, showed by far the greatest resistance to fading. Test prints created using Epson ink lost only 0.5 percent of image density in the ultraviolet light test, and only about 1.6 percent of image density in the ozone exposure test. So slight a degree of degradation is hard for the human eye to detect. Images created using Epson-

Inks Age Differently



LEXMARK'S OWN INK BEFORE



WALGREENS INK BEFORE



LEXMARK'S OWN INK AFTER

Lexmark brand ink faded marginally, yet noticeably, under exposure to ultraviolet light.



WALGREENS INK AFTER

Lexmark-compatible Walgreens ink, by contrast, lost 57 percent of its color density in our UV test.

Manufacturers' Inks Resisted Fading Better

PRINTER MAKERS' INKS usually stood up better than third-party inks to heightened levels of ozone and ultraviolet rays, though the OverStock.com and Cartridge World inks resisted ozone better than their Lexmark brand rival. The numbers below represent percentage of image fade, so lower is better.

PRINTER	Ink	Ozone fade	Ultraviolet fade
Canon Pixma MP830	Canon CLI-8	28.36%	10.03%
	Cartridge World	66.01%	21.63%
Epson Stylus CX5000	Epson No. 69	1.61%	0.06%
	123Inkjets	29.1%	35.96%
Lexmark X3470	Lexmark No. 1	3.32%	11.4%
	Walgreens	5.13%	57.01%
	Overstock.com	2.22%	22.12%
	Cartridge World	2.96%	28.29%
Kodak Easyshare 5300 ¹	Kodak 1963149	5.17%	1.45%

HOW WE TEST: For the ozone fade test, we gauged the ability of an image to resist fading when exposed to pollution—in this case, ozone. Each color was measured before and after seven days of exposure to 5 ppm of ozone; we recorded the percentage of image density loss for each color and then averaged the figures. For the light-fastness evaluation, we exposed sample prints to an increased level of ultraviolet light in a Q-Panel xenon-arc chamber for 80 hours at 63 degrees Celsius. We recorded the percentage of image density loss for each color and then averaged the figures. FOOTNOTE: No competing aftermarket ink was available for this model, so we compared the Kodak ink to other OEM ink brands in the market. NOTE: RIT did not obtain usable results in fade tests of HP and HP-compatible ink cartridges. Source: Rochester Institute of Technology

compatible 123Inkjet inks, the lone Epson competitor tested by RIT, lost an average of 36 percent of their image density under UV exposure, and 29 percent under ozone exposure.

The Kodak inks averaged 5 percent fade after 80 hours in the UV chamber, while fading only 1.45 percent under ozone exposure. (At the time of our testing, no compatible third-party ink had yet emerged to compete with Kodak's ink; LD Products has since brought out cartridges for the 5300.)

The Canon brand ink faded 28 percent under exposure to ozone, and 10 percent under UV light. Canon-compatible Cartridge World inks faded about twice that much—roughly 66 percent in the ozone test, and 22 percent in the UV test.

In RIT's UV test, the Lexmark ink proved far more fade-resistant than the Walgreens ink, and marginally better on average than the Cartridge World and OverStock.com inks. None of the Lexmark or compatible inks faded substantially in the ozone test. Canon supplies—particularly the black and green inks—faded noticeably, but Cartridge World ink faded even more in all colors except black. (See "Manufacturers' Inks Resisted Fading Better" at left for full details.)

And Now a Kodak Moment . . .

Kodak asserts that its cartridges have more going for them than a low price: Prints made with its inks are as vivid, colorful, and accurate as those made with any other manufacturers' inks on the market, the manufacturer says. We confirmed Kodak's claims on both counts: Kodak inks were as economical as the third-party inks, selling at \$10 for black and \$15 for color cartridges, the same price as cartridge refills at Walgreens. The Kodak inks' cost per page is fairly good, too, at 2 cents for black printing, 8 cents for color, and 12 cents for photo. Kodak inks earned scores on a par with those of the other manufacturers' inks in our print-quality tests, and rated especially highly in color glossy print jobs. And Kodak inks were second only to Epson in resisting ozone and UV light.

Brand-Name Cartridges Were More Reliable

Printer vendors say that their ink cartridges are more reliable and pose fewer technical problems in their own printers than third-party inks do. Most third-party ink sellers remanufacture (that is, buy, clean, and refill) used brand-name cartridges or resell cartridges that they buy from another manufacturer.

Our research tended to corroborate the printer manufacturers' claims. In the RIT tests, brand-name cartridges consistently installed and ran without a hitch, whereas some third-party supplies worked poorly or not at all.

For instance, a few Walgreens and OverStock.com cartridges designed for the Lexmark X3470 printer suffered from color mixing (in which ink from one cartridge leaks into another inside the printer) and from print-quality defects. Supposedly compatible Cartridge World cartridges—40 of them, in fact—failed to work in the Epson Stylus CX5000 printer and could not be tested. (The Epson unit's ink-replacement software utility reported, "The installed ink cartridge is incompatible with this printer," but didn't provide details.) And 2 of 20 Lexmark-compatible cartridges from Cartridge World arrived at RIT with ink leaking into the packaging prior to installation.

These reliability problems are not entirely the fault of the third-party ink sellers. Some manufacturers put microchips in their cartridges and printers, thus making it harder for third-party suppliers to design compatible supplies. "They'll put in a chip to keep third parties from being able to reverse-engineer" the product, says IDC printer analyst Keith Kmetz.

For instance, Canon ink cartridges include a computer chip

that thwarts third-party competitors. "Nobody's been able to replicate it, figure it out, figure out how to reset it, get around it," says Steven Eaton, store manager of Cartridge World in Folsom, California. "Printer manufacturers roll out new printers every six to eight months, and it's a struggle to keep up with all the new technologies," Eaton says.

Vendors also use scare tactics to discredit third-party products. "We see vendors saying your warranty could be affected if you're not using their genuine supplies," says IDC's Kmetz.

"Usage [of a third-party ink cartridge] alone does not void the warranty," says Tricia Judge, executive director of the International Imaging Technology Council, a trade group for toner and ink suppliers. The only way the warranty can be voided, according to Judge, is if a third-party product damages the printer. And if you're dealing with a legitimate aftermarket vendor, "They're going to repair or replace the printer for you if their cartridge damages it."

Our Ink-Stained Conclusions

Depending on your printer, you may be able to find cheaper, third-party inks that perform as well as or better than the brand-name stuff. In our study we found that third-party ink cartridges usually cost less and often yielded more prints than their manufacturer-made rivals. On the other hand, in most cases, we confirmed the printer manufacturers' claims that their own inks produce better-looking images.

Deciding between brand-name and third-party alternatives depends in part on how you plan to use your prints. If you >>

How We Tested the Longevity of Inks

ALL PHOTOGRAPHS FADE over time, as sunlight and pollution take their toll. But to determine whether printer manufacturers' inks last longer than those of third-party suppliers, researchers need to condense years of image fading into just a few days. How do they do it?

Technicians in the Imaging Products Laboratory at the Rochester Institute of Technology (RIT) place color prints in environmental

chambers where they can accelerate the prints' exposure to ultraviolet light and ozone—the atmospheric pollutants responsible for sapping the color from graphics as years go by.

For this *PC World* feature, RIT tested print samples from manufacturers' inks and from third-party aftermarket inks. Altogether, it tested ten cartridges per color, per vendor.

For the light-fastness tests, RIT technicians placed the print samples in a Xenon-arc chamber (see the image above) for 80 hours at 145 degrees Fahrenheit, exposing the samples to an increased level of ultraviolet light. In the chamber, brief bursts of high-intensity light mimic the effects of a low-intensity exposure over a period of many years.

The laboratory also ran tests to determine how well a print resisted the effects of ozone or pollution in the real world. In this test, RIT researchers measured the image's color values before and after a seven-day exposure to air containing 5 parts per million of ozone.



want high-quality color photos that future generations will be able to enjoy, then OEM inks are usually a better choice.

Many of us, however, don't need the best ink supplies that money can buy. If your prints tend to be for one-time-only office presentations, text documents for school, or temporary color images (such as plain-paper photos), inks from third-party supplies may be a reasonable cost-saving option. And over the lifetime of your printer, cost savings from buying third-party inks can be considerable.

An Ink Aftermarket in Flux

Finding suitable third-party cartridges for a particular printer isn't always easy, and may be getting harder. That's because selling third-party ink, we're told, is a tough business.

According to imaging industry forecaster Lyra Research, parent company of *The Hard Copy Supplies Journal* (a printer industry trade publication), printer manufacturers control about 80 percent of the market for replacement printer ink cartridges. Total worldwide revenue from inkjet cartridge sales will be about \$31.5 billion this year—\$25.1 billion of it going to printer makers and the other \$6.4 billion going to third-party cartridge sellers and refill shops or kiosks.

And experts say that third-party vendors' market share may be falling. "Overall, the OEMs are gaining back a little share, maybe a point or two over the next several years worldwide,"



THIRD-PARTY

Third parties sell cheaper ink in new or refurbished cartridges.

OWN BRAND

Printer makers sell pricier ink in cartridges built for their printers.

REFILL

Walgreens refills empty ink cartridges brought to its retail stores.

says Charlie Brewer, managing editor of *The Journal*.

One key factor in the printer manufacturers' dominance of the replacement cartridge market is a landmark 2007 ruling by the International Trade Commission (a U.S. government agency) that barred the importation of Epson-compatible ink cartridges into the United States. The immediate result for U.S. consumers is a big drop in the availability of third-party inks for Epson printers.

Another factor is the printer makers' aggressive and persistent

effort to take third-party vendors to court for infringement of their ink cartridge patents. "They're very litigious, they're very threatening, and they go after people," says patent attorney Edward O'Connor, who has been arguing printer industry patent-infringement cases for nearly 20 years.

Aftermarket lawsuits are nothing new, says IDC's Kmetz. The printer manufacturers "are not making as much money on the hardware as they are on the supplies, so any supply revenue that gets threatened is of great concern."

Printer vendors say they're just protecting their turf, not trying to mortally wound their aftermarket rivals. "We believe in fair competition," says HP's Brown.

Critics, however, charge that printer makers engage in bullying third-party vendors, most of which lack the resources to fight long legal battles. The resulting chilling effect discourages aftermarket competitors from selling ink, which in turn hurts consumers by keeping ink prices artificially high. ●

PHOTOGRAPH: ROBERT CARDIN

Where and How to Buy Cheap, Reliable Ink

THE AFTERMARKET FOR printer ink can be a tricky place to shop. Third-party cartridges cost less than the manufacturers' brands—which is why people buy them. But it can be a lot harder to tell whether a third-party vendor sells high-quality ink products.

One time-tested method is to shop at an established retailer (online or brick-and-mortar) that guarantees the quality of its products. Obvious examples include office supply chains such as 123Inkjets, Cartridge World, Office Depot, Office Max, and Staples, all of which carry third-party ink cartridges.

But finding third-party ink for your specific printer model can be a challenge, particu-

larly if your unit is very new, very old, or not very popular. Before driving around town to find the right cartridge, do a little homework online. At today's insane gas prices, you could end up spending \$20 on fuel just to save \$10 on an ink cartridge.

Like the online arms of other major retailers, Staples.com has an Ink & Toner Finder. Click the link for *Staples Brand Ink & Toner* to find a decent assortment of third-party supplies for Brother, Canon, and Lexmark printers. If you find compatible ink, you can buy it online or check with your local outlet to see whether it has the product in stock.

If you're dealing with a vendor that you

haven't used before, ask questions. A reputable online ink retailer will provide names and contact information for the ink manufacturers that it buys its supplies from.

When shopping for remanufactured cartridges, ask the third-party supplier how thoroughly it inspects used cartridges before refilling them. "Do they look for cracks? Do they test the electrical characteristics of the cartridge? A cartridge can look fine but have a broken electrical component, and then it won't work," says Tricia Judge of the International Imaging Technology Council. The vendor should also test the cartridge after the refill, Judge adds.