Tony Northrup's

Photography Buying Guide:

16 Hours of Video

HOW TO CHOOSE A CAMERA, LENS & TRIPOD, FLASH, & MORE

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However, you might notice that the Mason Press Rapid Publishing process has several drawbacks. First, the printing quality is not perfect because books are printed

individually, after they are ordered. Second, the book is only lightly edited. Therefore, you will see more mistakes than you would with a traditional printing process. If you find any mistakes, please email them to the author at tony@northrup.org, and he'll fix them for the next customer and add your name to the acknowledgements.

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Thanks for making me a part of your family!

Introduction

PLEASE READ THIS: In order to update this book as frequently as possible, it is very lightly edited. As a result, you'll certainly find typos and mistakes. This book is currently going through a full edit cycle which will fix all typos and grammatical mistakes. If you find a technical error, please email me at *tony@northrup.org* and I'll fix it for the next printing, and update everyone's ebook.

Video: Introduction 5:00 *sdp.io/pbgintro*	

This book is about making the best pictures you can for however much money you're comfortable spending. If that's $300 (USD), then this chapter has a recommendation for you. If it's $10,000, following the advice in this chapter will ensure that every penny is well-spent.

I've answered thousands of gear questions from readers of my photography techniques book, *Stunning Digital Photography*. As a result, I have a pretty good idea of what most photographers are looking for. If you're looking for quick gear recommendations so you can get started taking pictures as soon as possible, I'll give you those recommendations right away, without any unnecessary technical talk.

I also know that many photographers are interested in the different features of camera equipment, especially when they want to understand whether the features are worth the extra money. Because we all have different budgets and our own style of photography, there's no one right answer for everyone. For those of you who want to learn more about how your camera gear works, and how different features are used, I'll give you all the in-depth information you need to make wise purchases.

According to the people I've already helped by answering questions one-on-one, I've saved my readers hundreds of thousands of dollars. Saving money by carefully choosing your camera gear doesn't make you a cheapskate. In fact, you can spend the money you save on even more camera gear. By spending wisely, you'll pick the camera gear that will make the biggest difference in your photography.

I link directly to most of the camera gear I recommend, and I'd greatly appreciate it if you used the links in the book to buy your gear. I usually link to Amazon.com, because I get a small portion of what you spend as an Amazon gift certificate. I'll use the gift certificates to buy more camera gear, which I'll use, review, and then add more information to this book. Of course, you'll get the updates to the book for free. Oh, and you don't just have to buy camera gear through the links—I get a portion of any sale you make after clicking a link. If you're in the US, it would definitely help me if you visited this guide and clicked a link before buying anything on Amazon.

I do get a bit of money if you make a purchase from Amazon using my links, but you'll notice that I often recommend buying used from places such as eBay. I'd rather save you some cash whenever possible, and you can trust that my opinions are unbiased. If there's anything in this book you disagree with, please write me a note at *tony@northrup.org*. As with all of my photography books, I'll update the book based on your comments, and send the update to all my readers.

> While I insist on taking all my own photos for Stunning Digital Photography, many of the product photos in this book are provided with permission from the camera equipment manufacturers, including Canon, Nikon, Samsung, Manfrotto, and Sony.

Updating This Book

Please don't be annoyed if my recommendations would be different from yours, or if there's something in the book that outdated or wrong. Instead, write me an email (*tony@northrup.org*) and tell me how you disagree or what needs to be updated. I'll update the book with your thoughts, so that other readers can benefit, and I'll add your name to the acknowledgements as my way of thanking you for your contribution. Then, I'll send the update out to everyone who has

purchased the book for free.

Acknowledgements

This book is FAR too complex for one person to write. First, I'd like to thank the thousands of people who've personally asked me about camera gear in the last several years—your questions taught me what people need to know. I'd also like to thank everyone who told me I was wrong about something gear-related; I am always excited to learn something new.

Unfortunately, I haven't kept track of everyone's names. However, since the first release of the book, these folks have provided me important corrections, updates, and outside opinions: Kevin Girard, Mickey Whitlock, Jon Howard, Jayaram Krishnan, Yashar Armaghani, Michael Will, Martin Konrad, Gene Krumenacker, Alma Almanza Cárdenas, and you, too, if you contact me (*tony@northrup.org*) with any updates or corrections!

I'd also like to thank the equipment manufacturers who've provided me with loaner equipment for testing, including PocketWizard, Phottix, and Adorama.

How this Book is Organized

First, I will discuss the different types of cameras available: camera phones, point & shoot (P&S) cameras, mirrorless cameras, and Digital Single Lens Reflex cameras (DSLRs). Then, I'll help you decide which type of camera you need. Next, I provide buying guides for DSLRs and lenses with recommendations for specific models. Finally, I'll recommend specific accessories for you, based on the type of photography you plan to do.

Chapter 1: Camera Gear Basics

I know many people don't care about comparing features or understanding technical details; they just want a simple answer to their questions. If you don't already have a camera, here are my recommendations. If you do already have a camera that's a different make than I recommend, feel free to buy the lenses I recommend for your camera body.

Video: Our Favorite Cameras **11:13** *sdp.io/favorites*	

Do You Really Need More Gear?

Here's something to keep in mind: I've helped reviewed thousands of reader photos, and if the picture can be improved, I tell the reader exactly how to improve it. Only about 2% of the time do I recommend people upgrade their gear, and the vast majority of those are recommending adding an external flash or using a different lens. Only a couple of times have I recommended someone upgrade their camera body.

The lesson to be learned from this experience is that most people don't need more gear to make better pictures, they just need more practice and some post-processing. Of the people who do need to buy gear, most of that money should go to lenses and lighting.

The cost of your camera gear is not a reflection of your skill. Many people think that as they improve their photography skills, they should also improve their gear. Only seek out new gear when your current gear is failing you.

Bang for your Buck

Most of us have limited budgets, and need to consider which purchases will do the most to improve our pictures. Let's look at a couple of examples.

First, consider an amateur landscape photographer with the entry-level, 24-megapixel Nikon D3300 and its kit lens. His photography has gotten excellent, so he's considering upgrading to the much more expensive, 36-megapixel D810. The D810 is my favorite camera in the world, but for his needs, I'd tell him to keep the D3300 and spend the $3,500 he had budgeted for the upgrade on a trip around the world, visiting all the most beautiful landmarks with his D3300. For a landscape photographer, you'll see far more improvement if you spend your budget on travel and practice.

Now, consider a mom with the excellent Sony a6000. She loves taking pictures of her son's indoor basketball games, but many of the shots are out-of-focus. I'd tell her that her camera isn't well-suited to the task, because (in our tests) it doesn't track moving subjects as well as a DSLR. I'd recommend she sell her a6000 and buy a Nikon D5300. In this scenario, changing hardware will definitely improve her pictures, even though the camera isn't more expensive.

The landscape photographer would be better off spending his money on travel, while the sports photographer actually needed an upgrade. A portrait photographer might get better portfolio pictures by hiring a model and a makeup artist, or by buying lights. The best way for you to exchange money for improved pictures might not be by buying equipment; but it might be. In this book, I'll try to give you the information you need to decide for yourself.

Your First Camera

I've talked with hundreds of people in the process of buying their first camera. Here's the process they usually follow:

1. Look at a reasonably priced camera kit for sale.
2. Notice a camera that has a few more megapixels and costs slightly more.

3. Start looking at incredibly complex camera reviews, such as those at *dpreview.com*.
4. Discover crazy people who are passionate about nonsense such as high ISO performance, dedicated depth-of-field buttons, or Canon vs. Nikon vs. Sony.
5. Become flustered when they can't decide between two or three different similarly priced bodies, and worry that they're going to get the wrong camera and forever be cursed with taking awful photos.

Here's the process that I'm going to walk you through:

1. Determine a total budget that you're comfortable with.
2. Determine how much the accessories are going to cost you.
3. Buy any camera you can afford with the remaining money—used, if possible.

My primary goal is to get you out and taking pictures as quickly as possible. The fact is, your first camera really doesn't matter that much. Even the most basic camera kit is capable of amazing pictures. None of your Facebook friends are going to be able to tell the difference between a photo taken with a $300 camera or a $6000 camera, but they will notice the difference when you master composition, lighting, and posing.

When searching for Nikon and Canon DSLRs at Amazon, I see kits ranging from under $300 to over $6000. What do they all have in common? An average review of 4.5 stars—every single camera. They're all amazing cameras, and available at every price point, and the people who use them love them. You literally can't go wrong.

If you're afraid you'll buy the wrong camera and regret it, let me comfort you. If you become a casual photographer, any camera will do fine. If you become a serious photographer, you're going to want to upgrade your gear no matter which you buy. You don't know which gear is right for you until you get some practice shooting, however, because you haven't developed a style or discovered which types of photography you love. As your skills develop, there might come a point when your camera equipment can't keep up with you. At that point, you'll be able to sell your existing gear and get most of your money back (especially if you followed my advice and bought used in the first place), and put your money towards gear suited exactly to your specific style.

This book is for people who don't yet own a camera with interchangeable lenses, or who need guidance purchasing accessories. If you already have a camera that you're happy with, skip this book and spend the time taking pictures. I've talked to thousands of readers, and the most common mistake is buying too much camera gear too soon in their photography career. Sometimes, buying new gear is the answer to a problem, but most of the time, getting more experience or spending more time planning is a better answer.

Which Camera Should I Buy?

If you're asking this question without any additional qualifiers (such as, "Which camera should I buy for portrait/landscape/sports photography?") I'll recommend the Sony a5100 kit ($700). It's a great all-around camera that's easy to carry.

If you'd like to spend less, or you might want to invest in more serious lenses in the future, buy a *Nikon D3100 kit* or a *Canon T3/1100D* kit and don't worry any more about camera gear unless you start to struggle with your equipment's limitations. It should cost you around $400 new or $300 used. I know neither kit is the latest model, but they're great cameras at an amazing price. I've used them both, and they make amazing photos.

If you want to use the camera to take video, too, you might consider an upgrade to a Canon T3i/T4i/T5i or a Nikon D5100/D5200/D5300 (whichever is available). Those models are a bit more expensive, but they add an articulating screen, which makes video much easier to record.

If you have an unlimited budget, buy a Nikon D810 ($3,300), a Sigma 24-105 f/4 ($900), a Nikon 70-200 f/2.8 ($2,400), and 200 copies of this book.

These are quick recommendations that work well for most beginners, but there are hundreds of cameras on the market, and if you have specific needs (such as sports or wildlife photography, or if you're a more serious photographer), a different camera might be a better choice. Continue reading!

Which Lens Should I Buy?

This question is a bit trickier to answer, because which specific lens you buy depends on which model of camera you have. I provide specific recommendations for different types of cameras later in this book.

However, your kit lens is good enough for most casual, candid, landscape, and night photography. A great second lens is the 50mm f/1.8, often called the "nifty fifty" or the "fantastic plastic." This lens is cheap and fun, allowing you to get great background blur for nice portraits at a very low cost and it's perfect for many indoor sports. The nifty fifty is available for $100-$200 from Canon, Nikon, and Sony.

My favorite second lens is a 70-200mm f/2.8. Tamron makes an amazing $750 version, and you can find good deals on used lenses, too. I discuss lenses in-depth in the *Lens Buyer's Guide* section of this book.

If you'd like to upgrade your kit lens and you have an APS-C camera (and not a full-frame camera), I highly recommend the Sigma 18-35mm f/1.8 ($1000).

Video: Sigma 18-35 f/1.8 Review **23:03** *sdp.io/s35review*	

If you'd like to upgrade the kit lens on a full-frame camera, I recommend the Sigma 24-105 f/4 ($900). This lens is sharper than any standard kit lens and extremely versatile, making it the ultimate walking-around lens.

Video: Sigma 24-105 f/4 Review **5:02** *sdp.io/s105review*	

For more specific recommendations, including lower-priced options, read on!

Which Flash Should I Buy?

Again, this question is tricky because you have to choose a flash that's compatible with your camera model. However, if you have a Canon or Nikon camera, buy the Yongnuo YN-468 II (about $90) or the Yongnuo YN-568 EX (about $190). Name brand flashes are far more expensive and have lots of features you probably won't ever use, and if you do need them in the future, these flashes make excellent off-camera flashes. I provide recommendations for other flashes and information about flash features that you might need in the *Flash Buyer's Guide* section of this book.

Which Tripod Should I Buy?

Get the *Manfrotto MKC3-H01* (about $60). It's not the right tripod for every situation, but it's inexpensive and easy to carry. If

you need a more serious tripod in the future, you'll still use this one as your travel tripod. There's more detailed recommendations and descriptions of the features you should look for in *Chapter 10, "Tripod and Monopod Buying Guide."*

Video: Tripods 10:06 *sdp.io/tripodReview*	

Is Third-party Gear OK, or Should I Only Name Brands?

You should definitely consider off-brand lenses and especially flashes.

Generally, however, you get what you pay for. Tamron's $770 70-200 isn't as good as the $2,500 name-brand 70-200 f/2.8 lenses. It's not as sharp, it doesn't focus as fast, it lacks image stabilization, and it's not as durable. However, it will allow you to take professional portraits for under $1,000, and that's a feature the name brands can't offer.

Similarly, the $190 Yongnuo YN-568EX doesn't have all the features of the top-end name brand flashes, but it has the same flash output, and does everything most amateur and even professional photographers require for about one-third of the price. Even if you insisted on spending $600 on flashes, I'd recommend most photographers buy three of the off-brand flashes than one of the name brand flashes.

> **Tip:** Particularly with Chinese manufacturers such as Yongnuo, you can get even lower prices than normal by purchasing them on eBay directly from China.

Throughout this guide, I'll recommend third-party gear when it's a better value than the name brand gear.

Is it Safe to Buy Used?

Yes, pretty much. You can definitely find horror stories about used sales gone wrong, but eBay (and most used outlets) offer safety measures that protect the consumer from fraud.

I often buy equipment shortly after it's released, in which case, my only option is to buy new. However, anytime I buy equipment that's been on the market for more than six months, I buy used if I can. On modern equipment, buying used is an easy way to save 10-15% on lenses and 20-30% on bodies.

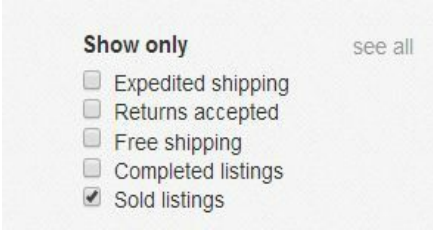
I've never had a problem, and I've bought about a dozen camera bodies and lenses on eBay. Here are some tips:

- **Know what you're buying**. You typically can return equipment that isn't as described, but you often can't arbitrarily return equipment because you changed your mind, like you might be able to when buying from Amazon or an electronics store. Be sure to read the description of the item for sale.
- **Buy from reputable sellers**. If a seller has more than 100 sales on eBay, and mostly positive feedback, they're serious and honest. You can almost certainly trust them. I generally don't buy from sellers with less than 10 sales or with recent negative feedback.
- **Check the return policy**. Many sellers offer returns within 14 days of purchase. If it isn't what you wanted, you can return it and just pay the shipping back to the seller.
- **Pay with PayPal**. PayPal offers important guarantees if something about the deal goes bad. You should read the complete agreement, but basically, PayPal has you covered if someone tries to scam you. Don't pay with Western Union, or a check, or any other means.

How can I get the Best Deal on Used Gear?

Selling prices for used gear varies tremendously. Looking at actual sales of one of my favorite used DSLR recommendations,

the *Canon 5D Mark II*, I see the body only selling for anywhere from $1,100 to over $2,000—with no obvious differences between the items. To make sure that you're the guy who got the $1,100 steal instead of overpaying by almost 100%, use these tips:



- **Check the actual sale prices**. Search for your item. Then, in the left page, under **Show only**, select **Sold listings**. This shows you actual sale prices for the item, so you know the least you can hope to pay for the item. With patience, you should expect to get your item for within 10% of that price.
- **Check multiple stores**. In the US, eBay is probably the top market for used camera gear. However, I often find better prices in the Amazon.com marketplace. Simply look up the product you want to buy on Amazon, and click the link for used prices. Also look for used equipment at keh.com, cameta.com, adorama.com/c/Used, and bhphotovideo.com.
- **Snipe on eBay**. eBay's user interface prompts you to enter a bid, and a maximum bid. Your bid takes effect immediately, raising the selling price of the item. If someone outbids you, eBay automatically increases your bid up to your maximum bid. Sniping is the process of using software tools to place a bid at the last few seconds before the auction ends. It sounds evil, but it's perfectly legitimate, and I highly recommend it because it keeps you out of the excitement of outbidding other people (known as a bidding war), which can cause you to pay more than you originally wanted to. I use the *Gixen* service, which is free, though I pay the $6/year to help support the service. If you pay for Gixen's service, you can bid on multiple copies of the same item, and if you win one of the auctions, Gixen automatically cancels your other bids. I use this to submit low bids on multiple copies of the same item, increasing my chances of getting a good deal. For example, when I bought a used Canon 7D, the average selling price was $900. I put a $750 bid on about ten different cameras, and got outbid on most of them, but with some patience, my $750 price did eventually win an item.
- **Resell bundle items**. Often, you can find listings that include the item you want, plus some other items that you don't want. Check the sales prices of the items you don't want, and consider buying the entire bundle and reselling the unwanted items. Naturally, you need to figure in the cost of the time it will take you to resell them. However, many of the best deals on eBay come from buying bundled items—particularly unusual bundles. For example, if you want a 5D Mark II, the best deal might be buying a 5D Mark II bundled with an unusual lens, such as anything other than the kit lens, because many people will overlook the listing. It's downright foolish to sell a camera with multiple lenses and accessories, but it can be very profitable to buy them.
- **Count shipping**. Though it's against eBay's terms of service, some sellers offer low sales prices but overcharge on shipping. Be sure to factor in shipping charges to calculate your total cost for an item.
- **Check the currency**. If you buy gear from another country, the price might be listed in a different currency. I once thought I bid $30 on a part that I won, only to discover that it actually cost me about $45—because the price of the item was in British Pounds rather than US dollars.
- **Don't sweat shutter count or dust**. I've never had a shutter fail in a camera, and I have more than a dozen bodies dating back to the 1940s. While shutters do technically have a limited number of actuations, and they'll eventually break because they are a moving part, it's a very rare occurrence. A little dust in the lens doesn't show up in images, either, but many people will avoid listings that show dust—giving you a great opportunity to get a good deal.
- **Go off-brand**. Products from Tamron, Sigma, Rokinon, Yongnuo, and other third-party lens and flash manufacturers tend to have a lower resale value. This makes them particularly strong used bargains.

What is Gray Market (or Grey Market)?

The gray market is the legal sale of products through unintended channels. For camera gear, it's often selling a camera body or lens in the US that was intended for the European market. Often, you can get grey market equipment for a lower price, and it's exactly the same gear.

There's one catch: the camera manufacturer might or might not provide warranty support. If they don't provide warranty support and your gear is faulty, then you would need to pay for the repair yourself. Of course, if you drop your camera and break it, it wouldn't be covered under warranty, anyway (you'd need insurance for that, instead).

I happily choose gray market equipment when the price is better. I've never had to send any piece of gear back for warranty

repair. I've definitely broken cameras and lenses, but that's wouldn't be covered under warranty, anyway.

If you buy gray market equipment from *B&H*, they will usually provide their own warranty directly, matching the manufacturer's warranty.

Which Software Should I Buy?

Fortunately, you don't need to buy any software. I never recommend using the software that comes with your camera. Instead, download *the free Google Picasa app*.

If you get more serious about photography, the *Adobe Creative Cloud Photography plan* is the best deal: $9.99 per month for both Lightroom and Photoshop (including free updates). Lightroom is for organizing your photos and light editing. Photoshop is for more serious editing. The two applications work best together.

Lightroom and Photoshop are the choice for almost every serious photographer in the world. Simply because of their popularity, there's also an almost unlimited amount of training materials available and a very large number of third-party plugins that extend their capabilities.

For a video overview of both Picasa and Lightroom, refer to Chapter 1 of *Stunning Digital Photography*.

Should I use the Adobe Creative Cloud?

Yes! *Creative Cloud is a bargain for photographers*. If you use other Adobe software, such as Premiere Pro (for editing your videos), you might consider Creative Cloud Complete, which is $50 per month, or $30 per month if you have a CS3-CS5.5 product eligible for upgrade. Creative Cloud Complete includes access to most of Adobe's software.

If you are a student or teacher with a .edu email address, Adobe will give you Creative Cloud Student and Teacher Edition, with all their software (including Photoshop and Lightroom) for $20 per month.

What Portrait Photography Equipment Should I Buy?

First, your kit lens is fine for group photos. Individual portraits benefit from fast, telephoto lenses that make facial features more attractive and blur the background, as shown in the next picture. Portrait work isn't particularly demanding on a camera's autofocus system, so you don't need to spend much on the body. However, full-frame sensors do blur the background better than compact cameras, as shown in the next picture. For detailed information, refer to Chapter 6 of Stunning Digital Photography.

If you're buying your first camera and plan to take portraits, here are recommendations for complete kits at different price points. In addition to the gear listed here, you'll need an inexpensive memory card—but portraits don't require large capacity or high-speed memory cards, so feel free to get something cheap:

- **$500 budget:** A *Canon T3 body ($320)*, a *Canon 50mm f/1.8 II ($100)*, and a *Yongnuo YN-468 II ($90)*. Total: $510.
- **$1,000 budget:** A *Canon T3 kit ($450)*, a *Canon 85mm f/1.8 ($420)*, and a *Yongnuo YN-468 II ($90)*. Total: $960.
- **$2,000 budget:** A Nikon D5300 kit ($850), a *Tamron 70-200 f/2.8 Di LD IF ($770)* , and a *Yongnuo YN-568 EX ($175)*. Total: $1,795.
- **$4,000 budget:** A Nikon D610 kit ($2,400), a Tamron 70-200 f/2.8 VC ($1,250), and a *Yongnuo YN-568 EX ($175)*. Total: $3,825.
- **$7,000 budget:** A Nikon D810 ($3,300), a Tamron 24-70 f/2.8 ($1,300), a Tamron 70-200 f/2.8 VC ($1,250), and three Phottix Mitros+ flashes ($400 each). Total: $7,050.

Notice that I recommend Canon bodies for the less expensive kits, but Nikon bodies for the higher-end kits. Current Nikon sensors have slightly better image quality, but the Nikon versions of the basic portrait lenses (a 50mm f/1.8 and 85mm f/1.8) cost more than the Canon equivalents. Because the Canon lenses are less expensive, I recommend the camera system for lower budgets.

Video: Portrait Equipment **15:28** *sdp.io/PortraitGear*	

These recommendations are for casual portraits with on-camera flash, but you might also need to set aside budget for multiple lights, props, and software. For more studio and location lighting, refer to the next question.

Sony has capable portrait equipment, but has less third-party support (especially for flashes), and the Sony 70-200 f/2.8 is priced comparable to the Canon and Nikon varieties, but is significantly less sharp. As mentioned above, these differences disappear if you use third-party lenses and monolights.

Many mirrorless cameras are very capable for portraits, too. However, you can get the same effect for significantly less by buying Canon or Nikon DSLR equipment. For example, the Fujifilm X-T1 ($1,700) and the 56mm f/1.2 ($1,000) lens will cost you $2,700. You could get similar field-of-view and depth-of-field with a Nikon D610 ($1,900) and the Nikon 85mm f/1.8 ($500), but the full-frame Nikon will give you better image quality and you'll have $300 left over for lighting. You'll also have the option to add the more flexible 70-200 f/2.8 later; nothing equivalent is natively available for any mirrorless system.

Video: 70-200 f/2.8 Shootout **23:50** *sdp.io/200test*	

Video: 70-200 f/2.8 Discussion **19:17** *sdp.io/200talk*	

What Wedding Photography Equipment Should I Buy?

Wedding photography doesn't require a great deal of equipment. Start with a fast normal zoom (such as 24-70mm f/2.8, or your kit lens). The normal zoom will be useful for group shots and photos of indoor receptions in enclosed areas. The Tamron 24-70mm Di VC USD ($1300 for *Canon*, *Nikon*, or *Sony*) is an ideal choice.

As a second lens, I like to use a telephoto zoom, such as a 70-200mm f/2.8. Follow the recommendations in the portrait photography section of this chapter. The telephoto range of the lens allows you to isolate subjects and simplify the background,

allowing a clean composition even when people are crowding around the bride and groom. Using a lens with a low f/stop number (such as f/2.8) allows you to further simplify the composition by blurring the background. When shooting more than one person, however, be sure to use a high enough f/stop number to keep everyone's face in focus.

Video: Tamron 24-70 f/2.8 Review

15:39

sdp.io/t70review

A powerful external flash is crucial. Outdoors, you'll need it to fill in shadows and add a catch light to your subject's eyes. I average 1,500 shots for a wedding, which is far more than any set of four batteries can provide. To give the flash more staying power and allow it to recycle faster, add an external battery pack. Lower-end flashes don't support connecting an external battery pack, but all higher-end flashes will. The flash recommendations in the portrait sections of this chapter are perfect.

If you have more than one camera body, even if it's an older camera, bring it, attach a different zoom lens to it, and wear them both. This will allow you to quickly switch focal lengths without changing lenses.

If you have enough memory, *shoot RAW*. Exposure can be very difficult because brides typically wear white, while grooms wear black. Shooting RAW gives you an extra stop or so of leeway, allowing you to recover burnt-out highlights and fill in black shadows on your computer.

You won't get the chance to re-shoot, so it's best to be over-prepared. Bring extra batteries for both the flash and the camera. Bring extra memory cards. If you can, bring an extra camera and lens—even if it's lower quality, it's still better than nothing. Borrow the extra equipment from a friend if you need to.

The wedding photographer's uniform is black: black pants, black shirt. You can wear a *photographer's vest* to carry extra batteries and lenses if you have one. You're going to be moving more than anyone else in the wedding, so choose comfortable (but black) shoes. Ladies, wear pants, because you'll find yourself climbing, leaning, and stretching to get the right angles.

Most professional wedding photographers work in teams of two: a lead and an assistant. Your assistant should have a camera, too. If they're less experienced, give them a wide-angle lens, put a bounce flash on it, and set it to automatic. It's good to have two people shooting the ceremony simultaneously; however, only one person at a time should shoot the posed pictures, so that people always know where to look. Also, it helps if at least one of the photographers is a woman, so that the bride will be more comfortable getting ready in front of her.

If you're buying a DSLR specifically to shoot weddings, look for a camera with these characteristics:

- **Great continuous autofocus**. You'll be shooting moving people when walking down the aisle and when on the dance floor. Therefore, a good autofocus system is critical. Almost any camera body will be good enough when using the center autofocusing point, so use continuous autofocus with the center autofocusing point on a basic camera, and shoot wide enough to allow you to crop for a nice composition. Cameras with advanced focus systems allow you to use many different focus points for reliable continuous autofocus, providing more flexible composition (at a much higher price).
- **Low noise at high ISOs**. Weddings often require you to shoot in low light, and adding flash could be unpleasant or distracting (especially during a church ceremony). Therefore, you often need to shoot with high ISOs, up to about ISO 6400.
- **Quiet shutter**. Many new cameras support a quite or silent shutter mode that will make you much more discreet, which is particularly important during the ceremony.
- **High dynamic range**. While less important than autofocus and high ISO, people at weddings tend to wear black and white. A camera with a high dynamic range will allow you to show detail in black tuxedos and white dresses. Be sure to shoot RAW!

If you plan to shoot weddings professionally, you'll need a professional camera. Weddings are hard work; you'll take hundreds of pictures, and you'll need fast focusing in low light conditions. If your camera messes up and causes you to miss a shot, you can't ever recreate it, and your clients will be crushed. Feel free to shoot a wedding with whichever camera you currently have, but be aware of the challenges you'll face. Be sure to read Chapter 7 in Stunning Digital Photography.

High-end cameras (typically priced over $2,500) are specifically designed for wedding photographers, and any of them will perform well. My specific recommendations for professional wedding photographers are, in order of preference and price from least to most:

- ***Nikon D810 ($3,300)***. The best overall camera in the world, the D810 has an excessive pixel count, incredible dynamic range, and matches or exceeds the 5D Mark III's autofocus capabilities.
- ***Canon 5D Mark III ($3,400)***. Low noise, relatively light weight, and an amazing autofocus system make this the best Canon wedding photography camera.
- ***Nikon D4 ($6,000)*** **or** ***Canon 1DX ($6,800)***. The physical size of these beasts will impress many of your clients, and when you trip over a little kid (or drunk lady) while backing up to take a shot, this indestructible camera definitely won't break. The autofocus systems beat everything else out there. Many people will still prefer the D810 or 5D Mark III, simply because it's much lighter and still very capable.

Finally, I'll make an unusual recommendation: get a film camera. It sounds crazy to go back to film, I know, but many wedding clients are impressed by a photographer who still uses film. You won't want to do the entire wedding with film, but plan some portraits with a nice film camera.

Film is romantic, whereas digital is quite cold. Many people grew up looking at the prints of their parents' and grandparents' weddings, and dreaming of the day their children would look through their own photo album. Plus, the negative is a true witness; it was there at the wedding, absorbing light that actually touched the happy family. Negatives are undeniably honest, never photoshopped, and survive hard drive crashes.

In short, a film camera can make you more marketable as a wedding photographer, even though it's not an efficient addition to your workflow, and it won't produce more accurate or detailed images. You can buy 35mm film cameras that fit your existing lenses, such as the Canon 1V or the Nikon F6. They function exactly like your modern DSLR, but nobody will even notice that you're shooting with film. Instead, I suggest a more romantic film camera, the medium-format TLR (shown in the black-and-white self-portrait). Choose a model that shoots 120 film, use T-Max 400 black-and-white film, and then develop and scan at *thedarkroo* Rolleiflex all make amazing TLRs, which you can find *used for $100-$1000*.

What Landscape Photography Equipment Should I Buy?

Probably nothing. While great landscape photography often requires intense planning, distant travel, and long hikes, it doesn't require expensive gear. Any camera and a kit lens will work fine for most landscapes.

While almost nobody needs to buy anything more than an inexpensive kit for landscapes, if you're planning to make large prints and you have a camera budget, or you want the best equipment possible, here are my ideal landscape recommendations for different budgets:

- **$500**: A Nikon D3200 kit
- **$700**: A Sony a5100 kit
- **$1,800**: A Sony a7K kit
- **$2,800**: A Nikon D610 ($1,900) and a Sigma 24-105 f/4 ($900)
- **$4,200**: A Nikon D810 ($3,300) and a Sigma 24-105 f/4 ($900)

You'll notice that I'm recommending full-frame cameras for those with the budget; they offer significantly less noise than compact cameras at their base ISO. The Nikon D810's ISO 64 support provides unbeatable detail and noise.

Canon cannot currently match the image quality of Sony and Nikon, and that's a key factor for landscape photography. However, if you're already invested in the Canon world, the 6D offers the same image quality as the Canon 5D Mark III, and the 5D Mark III is much more expensive than the 6D, and landscape photographers don't need the 5D Mark III's amazing autofocus system. Plus, the 6D has a built-in GPS, which is useful for keeping track of the locations of your landscape photos.

You'll also notice that I recommend the Sigma 24-105 f/4 lens instead of the wider *Canon 16-35mm* or *Nikon 14-24mm* zooms. Those are awesome lenses, but very few landscapes allow shooting at wider than 24mm. In fact, many landscapes are more telephoto, because few scenes left in the world allow you to shoot so wide without including distractions. Additionally, at super wide angles, distant objects such as mountains become tiny. For that reason, I bring only a single 24-70 when I'm shooting landscapes. If I have the opportunity to shoot wider, I shoot a panorama, as discussed in Chapter 2 of Stunning Digital Photography.

Many landscape photographers, most notably Ansel Adams, used tilt-shift techniques to provide greater depth of field. Using these techniques, they could focus on flowers or rocks in the foreground (shown in the next picture), while keeping distant mountains sharp. Canon offers several tilt-shift lenses (*17mm*, *24mm*, *45mm*, and *90mm*) and Nikon has a *24mm* and an *85mm*, each costing between $1,200 and $2,400. They're necessary for film work, but for digital landscapes, I instead recommend using focus stacking techniques. For detailed information about focus stacking, refer to Chapter 12 of Stunning Digital Photography.

If you plan on working in low light or at night, you will also need a tripod, as discussed earlier in this chapter.

What Wildlife Photography Equipment Should I Buy?

Video: Wildlife Photography Equipment

14:36

sdp.io/BirdGear

If you don't yet have a camera, here are some recommendations at different price points:

- **$500:** A *Canon T3 body ($320)* and a *Canon 75-300mm ($170)*. Check eBay or other used outlets to find gear even less expensive.
- **$750:** A *Canon T3 body ($320)* and a *Canon 70-300mm IS ($400)*. Adding image stabilization to the lens will allow you to use lower shutter speeds, reducing the noise in images of still animals such as perched birds.
- **$1,650:** A used *Canon 7D ($650)* and a used *Canon 400mm f/5.6 ($1,000)* prime. Avoid the 100-400 zoom; even though it sounds better, it's not sharp, and you'll only ever use it at 400mm. The Canon 7D is an excellent camera and offers far better autofocusing than the T3, but it's only a good value when bought used.
- **$13,000:** Buy a *Nikon D810 ($3,300) and a MB-D12 vertical battery grip ($350)*, a *Nikon 500mm f/4 ($8,400)* or *Nikon 600mm f/4 ($9,800)*, and a *Nikon 1.4X teleconverter ($500)*.

Video: Tamron 150-600 Review

16:27

sdp.io/t600review

If you want a high-end wildlife setup in the Canon world, choose the *Canon 70D ($1,200)*, the *Canon 1.4X III TC ($450)*, and the *Canon 500mm f/4 ($10,400)* or *Canon 600mm f/4 ($13,000)*. The Canon 5D Mark III is an incredibly capable wildlife camera, but I prefer the crop sensor of the 70D except for very close-range work, such as when I'm hiding in a blind.

The reason I recommend Canon gear for less expensive wildlife setups is the amazing *Canon 400mm f/5.6 ($1,300)* prime lens, which provides the sharpness of a $10,000 lens but is light enough to carry on hikes. I used it to take the following picture of an osprey flying, using my Canon 7D. Even though I have a much more expensive Canon 500mm f/4, I often choose the 400mm f/5.6 just because it's easier to carry. Nikon simply has no equivalent, and it drives many Nikon wildlife photographers insane.

The reason I recommend the high-end Nikon setup is the D810's incredibly high megapixel count, which provides astounding detail, often the most important factor in wildlife photography.

There's a huge jump from my $1,650 7D recommendation to the $13,000 D800 configuration. Oddly, there's very little middle ground for people with budgets somewhere in-between. My recommendation is to search used markets, such as eBay, for previous-generation *Canon 500mm f/4*, *Canon 600mm f/4*, *Nikon AF-S 500mm f/4*, and *Nikon AF-S 600mm f/4* lenses. While they still usually cost $5,000 to $7,000, that's a significant discount over the current generation prices of $10,000 to $12,000, and I'm still using the previous generation Canon 500mm f/4. The newer generation of lenses is sharper and lighter, which is a big advantage, but might not be worth $4,000 to you.

If you just want a wildlife lens for your existing camera body, here are the available lenses at different price points:

- 70-300, 75-300, or 100-300 f/4-f5.6: $125-$1,500, 1.5 lbs. (for all cameras, including micro four-thirds)
- Tamron 200-500mm f/5.0-6.3: $950, 2.7 lbs.
- Sigma 150-500mm f/5.0-6.3: $1,070, 3.2 lbs.
- Pentax 300mm f/4: $1,120, 3 lbs.
- 70-400mm f/4-f/5.6: $2,000, 5.6 lbs.
- *400mm f/5.6: $1,200, 2.8 lbs.*

- 300mm f/4: $1,400, 4.5 lbs.
- *400mm f/4: $6,000, 4.3 lbs.*
- 300mm f/2.8: $3,400-$7,500, 5 lbs.
- 400mm f/2.8: $7,000-$11,500, 11.8 lbs.
- 50mm f/4.5: $5,000, 6.9 lbs.
- 500mm f/4: $7,000-$10,000, 8.5 lbs.
- 600mm f/4: $10,000-$13,000, 11.8 lbs.
- 800mm f/5.6: $6,500-$13,000, 26 lbs.

Avoid telephoto lenses without autofocus, including Canon FD lenses, the Nikon AI-S lenses, and mirror lenses, unless you're only photographing still animals. You just won't be able to keep up with flying birds, and you'll miss a lot of still animals.

As you can see, bird photography can be a very expensive hobby. You can definitely find cheaper telephoto lenses, such as mirror lenses, but they won't give you as sharp pictures. One way to offset the high cost is to plan to sell your lens. Used lenses on eBay tend to get about 85-95% of the original purchase price. I bought a *100-400mm telephoto zoom* for $1500 and sold it twelve years later for $1250, so it only cost me a few cents per day to own. I've owned my 500mm for five years, and it has actually increased in value 12% because the manufacturer discontinued it. In fact, it's not usually worthwhile to buy a used lens because it doesn't save you much money. While it's usually cheaper to buy and then sell a lens, you also have the option of renting them from a local camera shop or an online service (such as *http://borrowlenses.com*).

Notice that most of the suggested lenses are not zooms. Zoom lenses are heavier and less sharp, and you won't need to zoom anyway—you'll spend all your time zoomed all the way in, and you'll still need to crop. For that reason, I typically recommend primes. However, at the entry level, wildlife photographers have gotten some amazing photos with the Tamron and Sigma zooms.

Unless you plan to only use your lens in your backyard, weight is an important factor. The heavier lenses take much sharper pictures, but traveling with a massive 9 lb. lens is difficult, and hiking any distance with that much weight is tiring. Most people can only hand-hold big lenses for a few seconds, so you will also need to bring a monopod, adding even more weight. The big, heavy lenses definitely take better pictures, but you must be willing to sacrifice convenience, or you'll find the lens sitting at home unused.

When choosing a camera body for bird photography, choose a body with a good autofocus system and a compact (cropped) sensor. While full frame cameras are overall superior (but more costly), the smaller sensor extends your telephoto lens even further. Essentially, it performs some of the cropping in-camera. Cameras with smaller sensors typically have a higher pixel density, meaning your pictures will actually have more resolution after cropping.

You can use a teleconverter to further increase your lens' focal length. If your lens has an aperture of f/2.8, you can add a *2X teleconverter* to it to double the focal length and increase the minimum f/stop number to f/5.6. If your lens has an aperture of f/4, you can add a *1.4X teleconverter* to it to multiply the focal length by 1.4 and increase the minimum f/stop number to f/5.6.

Teleconverters always reduce autofocusing speed, so I don't recommend using them for moving subjects. If you use a teleconverter on a lens with an aperture of f/5.6, you will lose the ability to autofocus. While you could manually focus, you generally can't do it quickly or accurately enough. Additionally, a 1.4X teleconverter slows your shutter speed by half, and a 2X teleconverter slows your shutter speed by four times. Those slower shutter speeds will force you to use higher ISOs, resulting in lower quality pictures. For those reasons, I recommend just cropping pictures instead of using a teleconverter with a lens that has an aperture of f/5.6.

Tip: If you have a 70-200mm f/2.8 lens, use it with a 2x teleconverter to get sharp pictures of larger birds.

Image stabilization is helpful when birding for two reasons: it decreases camera shake and it stabilizes the viewfinder. If you don't have image stabilization, you can eliminate camera shake by using a higher ISO and a fast shutter speed. In the case of flying birds, you will need a fast shutter speed to freeze motion anyway, which might seem to completely eliminate the benefit of image stabilization. However, I find that image stabilization makes it much more pleasant to look through the viewfinder—without it, looking through the lens is shaky and can even be nauseating if you do it for long enough.

For more information about wildlife techniques and equipment, refer to Chapter 8 of Stunning Digital Photography.

What Sports Photography Equipment Should I Buy?

Sports are challenging to photograph, and it's one of the few types of photography where a basic camera might simply not do the job. For action sports, you need a camera with a fast autofocus system, a high frames per second, and a fairly fast lens. For indoor action sports, you'll also need a camera that can support high ISOs with relatively low noise, and the fastest lens you can find.

Here are some recommendations for specific camera bodies:

- ***Canon 70D ($1,200)*** **or** ***Canon 7D*** *($1,200, or used for $500-$800)*. These two cameras have the same amazing autofocus system and similar image quality. Additionally, their compact sensors bring you closer to the action. However, their compact sensors also show a great deal of noise at higher ISOs, making pictures of indoor sports unbearably noisy. Therefore, they're perfect for outdoor sports, but you might consider upgrading to a full frame camera for indoor sports. The fast 7 and 8 frames per second allow you to take more photos during the most exciting moments, improving the odds that you'll catch the perfect shot.
- ***Nikon D7100 ($1,200)***. The Nikon equivalent of the 70D and 7D, the D7100 has a fantastic autofocus system and more megapixels than the Canon equivalents. The 6 frames per second is sufficient for sports, but the buffer fills up in one second if you shoot raw. Literally, it stops shooting after one second. You'll need to shoot sports with JPEG, which reduces image quality.
- ***Nikon D610 ($1,900)***. Nikon's entry-level full-frame camera is a great choice for indoor sports. Like the 6D, you'll want to use the center autofocus point and keep it on an area of contrast for reliable autofocus. The 6 frames per second is still a little slow for sports, too.
- ***Canon 6D ($1,900)***. The 6D is the least expensive Canon full-frame camera, and it will produce MUCH cleaner images for indoor sports. However, its autofocus system isn't as strong as the 70D or 7D. If you use the center autofocus point and are careful to keep it on an area of contrast (such as the number on a jersey), it will get the job done, however. The relatively slow 4.5 frames per second will make it difficult to catch that split-second when the ball hits the bat, though.
- ***Nikon D810 ($3,300)***. This camera has unbeatable full-frame image quality and detail perfect for indoor sports, even if you need to crop heavily, and it has a capable autofocus system. The 5 frames per second is rather slow for sports, but you can increase it to 6 frames per second in 1.2X and 1.5X crop modes, or 7 frames per second by adding the optional MB-D12 grip and using crop mode.
- ***Canon 5D Mark III ($3,500)***. This camera combines the excellent low-light image quality of the 6D with an incredible autofocus system that can keep up with the fastest action. The 6 frames per second can't keep up with the less expensive 70D or 7D, but the image quality makes up for it.
- ***Nikon D4 ($6,000)*** **or** ***Canon 1DX ($6,800)***. These monsters are clearly overkill for your kid's soccer game, but I felt like I had to mention them, since they're the choice for every professional sports photographer. These cameras have the best autofocus systems human technology has developed, and they each shoot over 10 frames per second. And, if an angry soccer dad attacks you, they double as weapons.

Notice that I don't currently recommend any mirrorless cameras for sports, despite the fact that they have very high frames per second and advertise the world's fastest autofocus. Even the best mirrorless camera for tracking moving subjects (according to our testing), the Fujifilm X-T1 ($1,700) doesn't track as well as less expensive DSLRs such as the Canon 7D.

For lenses, I typically recommend the same lenses I do for portraits, though you might want to add a 1.4x teleconverter, *as*

discussed in the Lens Buying Guide chapter. The Nikon recommendations are:

- $200: *Nikon 50mm f/1.8G AF-S DX* (sufficient only for sports you can get close to, such as basketball and volleyball)
- $500: *Nikon 85mm f/1.8G AF-S*
- $770: *Tamron 70-200 f/2.8*
- $1,500: *Tamron 70-200 f/2.8 VC*
- $2,400: *Nikon 70-200 f/2.8 ED VR II*

The Canon recommendations are:

- $100: *Canon 50mm f/1.8* (sufficient only for sports you can get close to, such as basketball and volleyball)
- $420: *Canon 85mm f/1.8*
- $770: *Tamron 70-200 f/2.8*
- $1,500: *Tamron 70-200 f/2.8 OS*
- $2,500: *Canon 70-200mm L IS II*

The Sony recommendations are:

- $170: *Sony 50mm f/1.8* (sufficient only for sports you can get close to, such as basketball and volleyball)
- $770: *Tamron 70-200 f/2.8*
- $1,500: *Tamron 70-200 f/2.8* (you don't need the image stabilization, but this lens is sharper and offers faster focusing)

Note that the Sony 70-200 doesn't make an appearance on my recommendations list. It's more expensive and not as sharp as the Tamrons, in my opinion.

I don't typically recommend using a flash for sports. Even though the light would help, the flash can disturb the players.

What Macro Photography Equipment Should I Buy?

First, I recommend everyone start with a set of extension tubes. Extension tubes are literally just empty tubes; they have no optical elements at all. They simply move your lens farther from the sensor, increasing the size of the image circle in the same way that moving a projector farther from the wall increases the image size. The following picture shows two extension tubes connected between a lens and a camera body.

Like diopters, extension tubes prevent you from focusing on subjects in the distance—the more extension you add, the shorter your maximum focusing distance becomes. Extension tubes also reduce light to the sensor, increasing your shutter speed and making it more difficult to focus. My unscientific experiments show that each 36mm of extension cuts the light by about half—requiring you to double your shutter speed. Therefore, you should use the least amount of extension possible to get the focusing distance that you need. Because it is different for every lens, the best way to find the right length of extension tube is trial-and-error.

Even if you later upgrade to a full macro lens, you'll still use your extension tubes for wildlife and portraits of babies. You can buy two different types of extension tubes:

- **Without autofocus ($10-$15)**. These extension tubes don't have wiring to carry electronic messages between the camera body and lens, which causes you to lose autofocus and aperture control. Losing autofocus isn't a problem for still-life macro photography, because you will usually manually focus anyway. Losing aperture control is a problem, however, because you frequently need to choose a high f/stop number to get the depth-of-field you need. There's a work-around described in the next section. I don't recommend extension tubes without autofocus, but if that's all that's in your budget, the Fotodiox models for *Canon*, *Nikon*, and *Sony* are under $15.
- **With autofocus ($50-$180)**. These extension tubes cost more, but they allow you to autofocus (which is important for

moving subjects) and they give you complete control over your aperture. Don't waste your money on the more expensive name-brand tubes; those from Kenko are the best, but many users report success with the Vivitar, CowboyStudio, and Zeikos models. They're really just hollow tubes, and the build quality won't impact your image quality. I recommend the Xit XTETS autofocus extension tubes for *Canon*, *Nikon*, and *Sony* ($57).

Macro lenses cost about $500-$1,000, which makes them far more expensive than using diopters or extension tubes with an existing lens. However, a true macro lens offers several benefits:

- **1:1 magnification**. This means that the image on the sensor is the same size as the subject itself. Basically, it means you can get very close to the subject. Some specialty lenses allow even greater magnification, such as the Canon MP-E macro lens ($1000) which focuses from 1:1 to 5:1, it's more like a microscope, however, than a traditional lens, and it can be very difficult to use.
- **Small minimum apertures**. Depth-of-field gets *very* small when taking macro pictures. To allow the greatest depth-of-field possible, macro lenses provide maximum f/stop numbers of f/22 or higher.
- **Restricted autofocusing**. It can take several seconds to autofocus a macro lens. To reduce that time, macro lenses often provide a switch to restrict focusing to specific ranges, such as between one and two feet, and between two feet and infinity.
- **Precision manual focusing**. Macro lenses tend to have finely adjustable focus rings that make it easier to focus on close-up subjects, but would require a great deal of spinning to focus on a distant subject.
- **Ring flash availability**. Depending on the size of your lens, the height of your flash, and the distance to your subject, your lens might cast a shadow on your subject when using a flash mounted to your camera. A ring flash mounted to the front of the macro lens eliminates shadows and provides a more even light, as shown in Figure 12-3. The ring flash must be matched to the front of the macro lens. Also consider using off-camera flash, as discussed in Chapter 3 and Chapter 6 of Stunning Digital Photography.
- **Infinity focus**. When you add extension tubes or diopters to a standard lens, you lose the ability to focus on subjects in the distance. A macro lens can always focus from extreme close-up to infinity.

You can add extension tubes to a macro lens to get even closer focusing. Add too much to the macro lens, and you'll literally focus inside the lens.

When shopping for a macro lens, one aspect that you need to pay particular attention to is dust resistance. While all lenses get some dust, you don't generally notice them. However, because you tend to use macro lenses to shoot close-up subjects, the dust inside the lens can become more in focus, ruining your pictures. Before you buy a used macro lens, look for dust inside of it by looking through the lens at a light from both ends. If, and when, you get dust inside your macro lens, be prepared to spend $150-$250 to have it disassembled and professionally cleaned. While you can clean the front and rear elements yourself, disassembling a lens to clean the internal elements is a task best left to optics professionals.

The macro lens you choose depends on your subject:

- **Still life**. You can get as close as you need to with still subjects such as flowers, so I recommend the Sigma 50mm f/2.8 macro lens ($370). The 50mm focal length provides more depth-of-field than lenses with longer focal lengths, and depth-of-field is a real challenge with macro photography. You'll also want a tripod for still life macro.
- **Insects**. Living subjects will run or fly away if you get too close, so you need more working distance. Often, they move so quickly that you need to hand-hold the lens, so image stabilization is an important feature. There's one lens that meets both these requirements: the Sigma 150mm f/2.8 OS macro lens ($1,100).

For information on using extension tubes and macro lenses, and information about other macro equipment (including reversing rings, diopters, focusing rails, and the amazing *Canon MP-E* lens), refer to Chapter 12 of *Stunning Digital Photography*.

What Equipment Should I Buy for Stars and Star Trails?

Note that I'm addressing wide-angle photos of the night sky in this section, and not close-up pictures of distant planets or moons.

First, I recommend starting with your kit lens. Master the technique, and make sure you have the stamina to stay out in the cold late at night. For detailed information about taking pictures of stars, refer to Chapter 10 of Stunning Digital Photography.

While your kit lens can get usable pictures of stars, it's not ideal. The ideal gear for astrophotography is a full-frame camera with a full-frame lens and the fastest aperture possible. In other words, you need a lens with a very low f/stop number.

On the other hand, autofocus is generally useless with stars; you'll always need to manually focus. Autoexposure is useless, too.

Rokinon, the third-party lens manufacturer you've never heard of, makes a series of all manual wide-angle lenses that are perfect for stars. Because Rokinon doesn't bother making the lens communicate with any of your camera's electronics, it's easy for them to attach different mounts to their lenses. As a result, these lenses are available for just about every camera mount ever made, including Canon, Nikon, Sony A and E, Pentax, Four-thirds, Micro Four-thirds, Sony, Samsung NX, and Fujifilm X.

		
Rokinon 14mm f/2.8 ($370)	Rokinon 24mm f/1.4 ($630)	Rokinon 35mm f/1.4 ($450)

Of these three lenses, I find the 24mm the most useful for stars; it provides sweeping views, and you can always crop if you need to. If you find you want to show even more of the sky, the 14mm is a good, but specialized lens. Unfortunately, it's two stops slower than the other lenses, so you'll need an ISO that's two stops higher when you use it—significantly increasing the noise in your photos.

What Equipment Should I Buy for Video?

While most of my recommendations have been DSLRs, mirrorless cameras shine for video because they tend to autofocus better and they have electronic viewfinders that you can use while recording.

When choosing a camera for video, choose a camera with a tilting or articulating screen, a touchscreen, and an electronic viewfinder. Though very few cameras currently support 4k resolution, I highly recommend it. 4k cameras provide sharper

video, even if you view them at standard HD (1080p). If you plan to shoot handheld, you need a lens or body with image stabilization. Power zoom helps, too.

At different price points, my recommendations are:

- **Sony a5100 kit ($700).** This mirrorless camera has an articulating screen, 1080p with 60 frames per second, and a power zoom switch on the body.
- **Panasonic FZ1000 ($1,000)**. This fixed-lens mirrorless camera is the cheapest way to get into 4k recording.
- **Panasonic GH4 ($1,700) and the Panasonic 14-140mm ($630)**. We use this combination daily for our filming, and it simply can't be beat for under $3,000.

Audio is extremely important. All modern cameras have a built-in microphone, but that sound will usually be awful. A full discussion of audio is outside the scope of this book, but you can get much better audio by attaching an external shotgun microphone and connecting it to your camera's mic jack (if your camera has one). Rode makes several excellent shotgun microphones.

If you're recording someone talking, you'll get the best audio by placing a microphone physically on the person. For our videos, we typically use a lavaliere microphone, more commonly known as a lav mic or lapel mic. We use the Sennheiser EW-100 G3 wireless lav mics, but at $600 per set, they're quite expensive.

If you learn the basics of video editing, you can record audio separately and synchronize it later using a tool such as Adobe Premiere Elements or Adobe Premiere Pro. We frequently use a Zoom H1 ($100) for this purpose; we'll simply place it on a table or in someone's pocket, and synchronize the audio later.

If you master synchronizing audio, you can use a variety of less expensive lav mics to get quality results. For example, you could connect the JK MIC-J 044 ($30) to an H1 and put the H1 in the speaker's pocket. Or, skip the H1, and connect a Rode smartLav+ ($80) to your smartphone.

Chapter 2: Choosing a Camera Type

Today, popular cameras fall into four main categories: smartphones, fixed-lens cameras (also known as point & shoots), mirrorless interchangeable lens cameras, and Digital SLRs (DSLRs).

Each have their own advantages, as the following sections discuss.

Smartphones

An interest in taking photos can start with a camera phone. You simply can't beat the convenience of a camera that can send a picture to your friends in 10 seconds. As photographer Alexander Hollander demonstrates, it's possible to make amazing pictures with a camera phone. To see Hollander's pictures, check out the Mobile folder in his Flickr photostream at *http://www.flickr.com/photos/alexanderhollander*.

- **Convenience**. I carry my phone with me everywhere, so I always have it. As commercial photographer Chase Jarvis is credited with saying, "The best camera is the one that's with you."
- **Detail**. Modern camera phones take pictures with more than enough detail for *Facebook* or even moderately large prints. For example, the iPhone 5S' 8 megapixel camera can make 11x17" prints at more than 200 dots per inch (dpi), providing enough detail that the average person wouldn't be able to distinguish the print from that made with a professional DSLR.
- **Software**. Because modern smartphones have a great deal of processing power, the camera apps are often feature-rich, supporting High Dynamic Range (HDR, as discussed in Chapter 11 of Stunning Digital Photography), Panoramas (as discussed in Chapter 2), and powerful image editing capabilities such as those provided by *Instagram* and similar apps.
- **Connectivity**. Camera phones are constantly connected to the Internet, allowing you to take a picture, edit it (optionally), and then message it to someone directly or post it on Facebook or Twitter. Recency is one of the most important factors in photography—a picture of your son hitting a home run last week will be interesting to his grandparents, but a picture of him hitting a home run 20 seconds ago can make them feel like they're standing next to you. It also allows you to get immediate feedback from friends anywhere in the world.

While camera phones provide great detail, they fail in many other ways:

- **No zoom**. All popular camera phones have a non-interchangeable, wide-angle fixed focal length lens. In other words, you can't zoom, and zooming is the single most important feature in any lens. Digital zooms aren't useful because they make everything blurry; you're better off just cropping the picture after you take it. You can buy *lenses that attach on the outside of some camera phones*, but they're inconvenient and the picture quality isn't great.
- **Awful flash**. Camera phones feature a bright LED located very close to the lens. Typically, you have no control over the flash except to turn it on or off. The flash produces red-eye (which might be fixed automatically in software), blows out nearby subjects, and leaves anything farther than a few feet away in darkness. Once you use a bounce flash (discussed in Chapter 3), you'll never be able to tolerate your camera phone's flash.
- **Slow speed**. DSLRs take pictures within milliseconds of you pressing the shutter. With a camera phone, you often have to wait a full second or more before the camera app takes a picture. That's fine for a landscape shot, but if you're trying to take a picture of your son blowing out his birthday cake candles, you're likely to get a photo of nothing but smoke.
- **Limited or difficult controls**. Many smartphones over almost no control over the camera's settings. Some apps allow you to control the exposure, aperture, ISO, and shutter speed. However, changing the settings is a slow process of tapping on the touch screen. DSLRs typically have physical dials that you can spin to immediately get the settings you want.
- **No background blur**. You'll never get a nicely blurred background from a camera phone picture unless you download an app that blurs it after you take it.

Because of these drawbacks, camera phones are still frustrating to use for all but the most casual snapshots. No matter which serious camera you buy, your smartphone will always get used because of its convenience.

Fixed-lens Cameras

Fixed-lens cameras come in every size, shape, quality, and cost, and the only trait that brings them together is the lack of an interchangeable lens.

Most casual photographers only ever use their kit lens. If you want a high-quality camera for general use, and you don't plan to shoot serious sports, wildlife, weddings, portraits, or astrophotography, a fixed lens camera is the right choice for you. Basically, I recommend a fixed lens camera to everyone who wants to take great pictures but doesn't want photography to become a hobby or profession.

The smallest fixed-lens cameras, (P&S) fit in your pocket, and require very little understanding of photography to take in-focus and well-exposed pictures. P&S cameras were the most popular camera type from about 1980 until about 2010. Before 1980, the technology simply didn't exist to make cameras that were easy enough to use to be considered point-and-shoot.

P&S cameras are a dying breed, however. While having a zoom lens is a big advantage over camera phones, the cost of buying a separate camera and the inconvenience of carrying it around just isn't worth it for most people. As a result, I recommend people use their camera phones for snapshots and a mirrorless camera or DSLR for more serious photos, and completely avoid P&S cameras.

There are also a growing number of fixed-lens cameras that bridge the gap between P&S cameras and DSLRs by offering bigger sensors, powerful lenses, manual controls, and external flash support. Their picture quality can be similar to DSLRs, giving you all the capabilities in a smaller, (sometimes) less-expensive package. Here are some quick recommendations:

- **Casual**. The Canon Powershot S120 ($450) is an excellent all-around camera and a big step up from a smartphone. With built-in Wi-Fi and a touchscreen, you can still get pictures to your smartphone (and thus to Twitter or Facebook) to share with your friends without going back to a computer.
- **DSLR companion**. If you want a camera with manual controls that you can carry with you when you don't want to bring your DSLR, consider the Canon G16. The lens is equivalent to a 28-140mm f/8 to f/13, so it's not great in low light, and you won't be able to blur the background in portraits. But, at least you won't be lost without exposure compensation.
- **Sports and wildlife**. Many fixed-lens cameras brag about "40X" f/2.8 lenses, but they're being deceptive. You can find photographers who've taken great sports and wildlife photos with a fixed-lens camera, but it's much more difficult than it would be with a DSLR. If you plan to shoot sports and wildlife, your money is simply better spent on a DSLR.
- **Video**. The Panasonic FZ1000 ($1,000) is the cheapest way to get into high-quality 4k video. Panasonic is misleading when they advertise the lens as "25-400mm f/2.8-f/4.0", however. The lens is physically 9.1-146mm f/2.8-f/4.0, and in full-frame 35mm terms, it behaves like a 25-400 f/8-f/11 lens. That's lousy for a still camera, but fairly useful for a video camera.
- **Serious, planned photography ($1,300)**. The Fujifilm X100S and newer X100T ($1,300 new, or $850 used) have an APS-C sensor and a prime 23mm f/2 lens that's equivalent to a 35mm f/3 lens. They feel like an old-fashioned viewfinder camera in your hands. They lack a zoom, or the ability to change lenses, making them very specialized. The X100T offers a better viewfinder, a full control dial, a silent shutter, and a handful of other useful features. You might find a great price on a used X100S, however.

- **Serious, planned photography ($2,800)**. The Sony RX-1 ($2,800 new, or $1,800 used) has a full-frame sensor and

a prime 35mm f/2.0 lens with amazing image quality and low-light capabilities unmatched at this size. Like the X100S, the prime lens limits your options, but when the conditions are right, this camera takes sellable, professional-grade images.

As discussed later in this book, f/stop numbers are meaningless unless you factor in the camera's sensor size. Most people don't know this, however, and many fixed-lens camera manufacturers take advantage of this ignorance mislead customers into believing a lens performs better than it actually does.

For example, consider the Sony RX-10, which advertises a 24-200mm f/2.8 lens. Many photographers mistakenly believe that it will perform like a DSLR with a 24-70 f/2.8 and a 70-200 f/2.8 lens attached. However, if you calculate the crop factor (about 2.7X) you discover that the lens gathers the same amount of total light and provides the same background blur as a 24-200 f/7.6 full-frame 35mm lens. That's substantially worse than a full-frame f/2.8 lens. For more information, refer to the *Sensor Size and Crop Factor* section.

Mirrorless Interchangeable Lens Cameras

Mirrorless cameras (formally known as Mirrorless Interchangeable Lens Cameras, or MILCs) are the right choice for most non-professional photographers who don't need access to the wide variety of Canon and Nikon DSLR accessories.

Mirrorless cameras combine some of the best qualities of P&S cameras and DSLRs:

- **Interchangeable lenses**. Whereas P&S cameras have a lens built-in, mirrorless cameras support interchangeable lenses. This makes them substantially larger than a typical P&S camera when the lens is attached, however, being able to change lenses makes the cameras infinitely far more versatile than a P&S camera.
- **Small size and light weight**. Besides being more portable, small cameras are less intimidating. That makes them better for candid and street photography, where the photographer doesn't want to be noticed.
- **Manual controls and advanced features**. Mirrorless cameras typically allow for manual control of shutter speed, aperture, ISO, and exposure compensation. Additionally, through the power of software, they provide advanced features such as bracketing, panoramas, and HDR.
- **Raw file formats**. Saving raw files instead of JPG files gives you much more flexibility for recovering overexposed highlights and fixing other photographic problems. Almost every photographer who does post-processing chooses raw files instead of JPG, so it's no surprise that mirrorless cameras support raw file formats, just like DSLRs.

Mirrorless camera technology is advancing far faster than DSLRs. If you used a mirrorless camera in 2012, you might have been annoyed by the limited lens selection, slow performance, poor viewfinder, and noisy images. In 2014, mirrorless cameras match DSLRs in many different aspects of photography, including image quality. By 2020, I'm confident that even professionals will be buying more mirrorless cameras than DSLRs.

If you're a DSLR user and you have your doubts about mirrorless cameras, spend a full day shooting with a Panasonic GH4, Fujifilm X-T1, or Olympus E-M1. The next time you pick up a DSLR, it will seem clunky and impossibly heavy. The optical viewfinder will seem outdated compared to the electronic viewfinders, which are bright even at night, show you your exposure before you take a picture, and provide histograms and focus peaking.

But I don't recommend mirrorless cameras to everyone. No mirrorless system can match the variety of Canon and Nikon DSLR lenses and flashes. Mirrorless lenses and flashes cost more than comparable DSLR lenses and flashes, too. Despite manufacturer's claims, none of them can track moving subjects as fast as a comparably priced DSLR.

There are no bad mirrorless cameras on the market now—you literally can't go wrong. However, to make your shopping a little easier, here are some suggestions, depending on your priority (prices include lens):

- **Cheapest**. The Olympus PEN E-PL3 ($250 new, $150 used) isn't the newest model, it's a little slow, and it has only a 12 megapixel sensor. However, it's small, light, has a tilt screen, accepts the massive variety of Micro Four-thirds lenses, and the image quality is more than enough for beautiful 8x10" prints.
- **Smallest**. The Sony a5100 ($700) has fantastic still and video image quality in a very small size. The selfie

touchscreen, wireless capabilities, and small size make it a great family camera.

- **DSLR companion**. If you have a DSLR but want something smaller to bring with you, the Olympus E-M10 ($650) has plenty of buttons and dials for manual controls, and it looks great in silver. With in-body image stabilization (IBIS) you can attach any lens, including prime lenses and adapted SLR lenses, and hand-hold at slow shutter speeds. My favorite lenses are the original Panasonic 20mm f/1.7 (for general use) and the Panasonic 45mm f/1.8 (for casual portraits).
- **Best handling**. The Fujifilm X-T1 ($1,700 with a lens) is expensive, but old-school photographers will love the real shutter speed, exposure compensation, and ISO dials with the number written right on them. For best results, use a Fujifilm prime lens with an aperture dial.
- **Best video**. You can't beat the amazing Panasonic GH4 ($1,700) with 4k video. Combine it with the Panasonic 14-140 ($630) lens for amazing results in a tiny, discreet package.
- **Most DSLR-like**. If you like the feel and functionality of a DSLR, but you want something smaller and lighter, I again recommend the Panasonic GH4 ($1,700). The electronic viewfinder is better than a DSLR's optical viewfinder for most subjects, it can take 12 frames per second, and the electronic shutter allows for completely silent operation.
- **Best image quality**. The Sony a7R ($2,100) uses a 36 megapixel full-frame sensor, the same size as professional DSLRs, but at a much smaller size. The Sony 24-70 f/4 ($1,200) is the best walking around lens for it. That kit is expensive at $3,300, but you'll get similar image quality to the best DSLRs at a lower price and weight. I will still recommend the Nikon D810 ($3,300 body only) to most photographers over the a7R, however, because the D810 has native support for more than 100 lenses, while there are only 5 native lenses designed for the a7R.

Beyond those recommendations, I would steer you towards either the Sony lineup or micro four-thirds cameras because of the wider range of lenses and accessories available to you. If image quality is particularly important to you, or you like low-light photography, choose a mirrorless camera with an APS-C sensor.

Notice that I haven't mentioned the Canon and Nikon mirrorless camera systems. They're good, and they take great pictures. However, the big players in the DSLR market arrived a bit late to the mirrorless market, and their products simply aren't as refined. I'm confident that they'll have caught up within a couple of years, and I'll be updating this section to recommend their newer entries.

Digital Single Lens Reflex (DSLRs)

Digital Single Lens Reflex (DSLR) cameras are both the least and most expensive types of cameras. If you want to get the most camera for your budget, buy a used DSLR. If you are a professional photographer, or you want to shoot like one, a DSLR is the best choice for you.

Like mirrorless cameras, you can change the lenses and flashes on DSLRs. DSLRs have a few key advantages over mirrorless cameras:

- **Lens selection**. Canon and Nikon DSLR systems are the oldest, and thus they have the widest selection of lenses. This doesn't make any difference if your choice of camera system has all the lenses you need. However, serious portrait, wedding, sports, and wildlife photographers often need lenses only available to Canon and Nikon DSLR users. For example, there is no true mirrorless equivalent for the flexibility and shallow depth-of-field provided by the 70-200 f2.8.
- **Lens cost**. DSLRs lenses tend to be less expensive than equivalent mirrorless lenses. For example, the Sony E-mount 50mm f1.8 is $300, while the Canon equivalent is $125 and the Nikon equivalent is $215. Kit lenses aside, mirrorless lenses tend to be 50%-300% more expensive than the DSLR equivalents. If you plan to buy a wide variety of lenses, a DSLR might simply be less expensive than a mirrorless camera.
- **Focusing on moving subjects**. DSLRs are defined by the mirror that bounces light from the lens to the viewfinder. This same mirror also reflects light to a dedicated phase-detect focusing system. While mirrorless cameras focusing systems have improved to the point that they focus just as well as DSLRs on still subjects, our tests show they are substantially less reliable for tracking moving subjects.

If you're in the market for a DSLR, I have good news: it's easier to buy your first DSLR than it is to buy your first P&S camera. There are no bad DSLRs on the market now—you literally can't go wrong. However, to make your shopping a little easier,

here are some suggestions for different budgets, depending on your priority (prices include lens):

- **As inexpensive as possible**. The *Canon T3 kit* or *Nikon D3100* (both about $400 new or $300 used). These basic cameras do almost everything the more expensive cameras do, but they might require just a bit more patience. Remember, every dollar you save is a dollar more you can spend on lenses, flashes, and tripods.
- **Up to $1000**. The *Canon 60D*, *Nikon D3300*, or Nikon D5300. A solid step up from their basic counterparts, these models offer improved usability and image quality.
- **Up to $1,500**. The *Canon 70D* or *Nikon D7100*. The ultimate amateur sports and wildlife cameras, these bodies are the top-end compact cameras. The Canon 70D is also a capable video camera thanks to its video autofocusing capability.
- **Up to $3,000**. The *Canon 6D* or *Nikon D610*. These models provide full-frame sensors with image quality that leaps ahead of the less expensive models. Full-frame sensors are ideal for landscapes and portraits, but less useful for sports and wildlife.
- **Up to $4,000.** The *Canon 5D Mark III* or *Nikon D810*. These full-frame models offer the greatest possible image quality with dramatically improved autofocus systems.

Whenever possible, save yourself some money and buy refurbished or used equipment on eBay. Bodies, in particular, are often available used much cheaper than new, and they work just as well as their new counterparts. Newer bodies are rarely available used, requiring you to pay full price for them. Be sure to buy from a reputable buyer, and choose buyers that offer a return period whenever possible.

I generally have no strong preference between Canon and Nikon. Each of the bodies at a similar price point creates similar pictures, and you shouldn't worry too much about minor features. If you're the type who wants to get started shooting as soon as possible, just buy the camera from the previous list that fits your budget, and start shooting.

If you're the type who wants to understand every aspect of a camera you're buying, or if you're considering upgrading your existing body and you don't know if it's worth it, continue reading this section. My goal is to inform you about the different factors that might influence your buying decision so that you can determine the factors that are most important to you and make an educated decision.

If you just want to see an overview of the different camera bodies available, skip to the buying guides for *Nikon*, *Canon*, and *Sony*.

Chapter 3: Camera Body Features

This chapter marks the end of quick recommendations until you get to the brand-specific buying guides at the end of the book. We'll dig deep into the factors that influence camera body buying decisions, including lens availability, image quality, and speed.

Lens Mount

There's one camera trait you need to choose before thinking about features: Lens mount. Lens mount determines the availability of accessories, such as add-on lenses and flashes.

There are currently about 17 different popular lens mounts, which makes camera shopping incredibly complex. For most people, I recommend choosing one of the six most popular lens mounts: Nikon DX (APS-C DSLR), Canon EF-S (APS-C DSLR), Sony E-Mount (APS-C mirrorless), Micro four-thirds (mirrorless), Nikon FX (full-frame DSLR), or Canon EF (full-frame DSLR).

Though you'll no doubt find horror stories about each of them, your odds of getting good prices, support, and accessories are roughly equal. Canon and Nikon are constantly playing catch-up with each other. At times, Nikon has had superior technology. Within six months, though, Canon will release a camera or lens that very slightly surpasses Nikon's. This is free-market competition at its finest, and it works so well that you can be confident with your purchase from either brand.

With that said, some photographers might appreciate the subtle differences between brands:

- **Nikon**. I recommend Nikon DSLRs to anyone who is primarily focused on image quality, especially stock, commercial, fashion, and landscape photographers. Nikon DSLR cameras have about 30% better image quality than the Canon equivalent at that price point.
- **Canon**. I recommend Canon to beginning wildlife photographers because Canon has a slightly better selection of telephoto lenses. In particular, there's no Nikon equivalent of the excellent *400mm f/5.6*, which is very sharp mid-level birding lens at $1,300. Additionally, all Canon camera bodies can autofocus with older Canon EOS telephoto lenses, whereas older Nikon only autofocus with bodies that have a focusing motor. At the high-end, Canon has recently refreshed their *500mm* and *600mm* lenses, and while they're very expensive at more than $10,000, they're a bit sharper than the Nikon equivalent.
- **Sony**. I recommend Sony E-mount APS-C mirrorless cameras to casual photographers and my friends who love gadgets. If you've always got the latest cell phone, the lightest tablet, or the newest electric car, you'll love Sony. They've added cool features, like Wi-Fi, NFC, and downloadable apps. The downside to being the new kid on the block is that Sony doesn't have as wide a variety of modern lenses, flashes, and third-party accessories as Canon and Nikon, but they do have all the gear most amateur photographers will ever need. I don't often recommend Sony's DSLR cameras because I believe Sony will soon abandon DSLR format and put their energy into their mirrorless cameras.
- **Micro four-thirds**. I recommend Micro four-thirds cameras, such as Panasonic and Olympus cameras, for potentially serious photographers who prize small size and light weight over image quality. The Micro four-thirds format is unbeatable for budget video. Lenses tend to be more expensive than their Canon and Nikon equivalents, however, especially for higher-end lenses. For example, the Olympus 35-100 f/2 ($2,500) is equivalent to a Canon or Nikon 70-200 f/4 ($1,300).
- **Pentax**. While not as popular as Canon and Nikon DSLRs, Pentax DSLRs offer in-body image stabilization (IBIS) and better weather sealing. If you need an inexpensive camera that can survive wet conditions, or you plan to buy prime lenses and hand-hold them (instead of using image stabilized zooms), Pentax is ideal. Pentax has some third-party support from Tamron and Sigma, but many lenses are not available for Pentax.
- **Fujifilm**. Fuji X-mount cameras are perfect for old school photographers who love buttons, dials, and manual settings, and who aren't afraid to read a camera manual. If you like Leica cameras, I'd probably steer you to Fujifilm instead, because they have the same soul at less cost. Fuji's not popular enough to get lens support from Tamron and Sigma, which is a big drawback—you're limited to the handful of lenses Fujifilm sells. You can adapt lenses, but you'll usually lose autofocus and aperture control.

I hesitate to recommend many other lens mounts because they have limited lens support or I'm uncertain that the manufacturer

will continue making new lenses and cameras in the future. Nonetheless, I have dedicated chapters later in this book to every single major lens mount, so you can explore every manufacturer's offerings.

Don't take those comments too seriously; the differences don't matter too much. There are many amazing wildlife photographers shooting with Nikon gear, Canon cameras have amazing image quality for thousands of pros, and if you have a Sony camera, you'll probably always be able to find the accessories you need. These camera manufacturers are 99% the same. Plus, they're constantly releasing new gear to fill in any gaps, so any advantages or disadvantages are temporary.

Video: Canon vs Nikon

25:12

sdp.io/cvn

When you buy an interchangeable lens camera, you'll get the best results if you use the lenses designed for that system. Therefore, it's important to consider the body and lens variety for each system. The following table lists the most popular mirrorless systems in rough order of popularity, along with the approximate number of camera bodies and lenses designed for the system. The highlighted rows are my most commonly recommended systems.

System	Current Bodies (approx.)	Native Lenses (approx.)
Nikon Full-frame DSLR	4	100+
Nikon APS-C DSLR	5	25
Canon Full-frame DSLR	3	100+
Canon APS-C DSLR	7	15
Sony APS-C Mirrorless	15	20+
Sony Full-frame Mirrorless	3	5
Sony APS-C DSLR	2	12
Sony Full-frame DSLR	1	24
Micro four-thirds Mirrorless	25	50+
Pentax 645 DSLR	1	17
Nikon 1 Mirrorless	10	13
Canon EOS M DSLR	3	3
Samsung NX	8	24
Pentax K	5	40
Fujifilm X/XF	2	5
Pentax Q	2	6
Leica M	3	38

Note that Canon, Nikon, and Sony APS-C camera bodies can use same brand's full-frame lenses, albeit with a drop in image quality. With a few exceptions, I generally recommend upgrading to a full-frame body before investing in full-frame lenses.

Note that I'm not listing the number of DSLR lenses that can be connected to the system using adapters; I discourage you from factoring these lenses into your decision-making process because their size defeats the purpose of using a mirrorless system in the first place, and handling and autofocus tend to be clumsy. I do understand that DSLR lens compatibility is an important factor for people with existing equipment, so if you have several Pentax K-Mount lenses that you want to use on a modern digital mirrorless camera, you should buy the Pentax K-01. If you want to use your Canon DSLR lenses on a mirrorless body, you should get the Canon EOS M.

Do think through this choice carefully, however, because lenses designed for mirrorless systems are much smaller and lighter, and those are the biggest reasons to get a mirrorless system in the first place. If you want to use DSLR lenses, I advise you simply to buy a DSLR. If you don't want to lose your investment in DSLR lenses but you do want to use a mirrorless body, I advise you to sell your DSLR lenses and put the proceeds towards native lenses.

Display Articulation

Cameras have four types of displays:

- **Non-articulating**. The screen is fixed to the back of the camera and can't move. This is the most durable design, and all high-end DSLRs have a non-articulating screen.
- **Tilt screen**. Tilt screens tilt up or down 90 degrees. This is very useful for holding the camera low to the ground (for kids and flowers) or high in the air (for shooting over a crowd).
- **Selfie screen**. Selfie screens tilt up 180 degrees, allowing you to see the display while being in front of the camera.
- **Fully articulating**. Fully articulating screens flip 180 degrees from the side, providing the greatest flexibility. They're also the least durable, though I've never broken an articulating display.

Whenever possible, I choose a camera with a fully articulating display, especially if I plan to take video. However, many high-end cameras lack the option. The following product images show a tilt screen, selfie screen, and a fully articulating screen.

Viewfinder

The viewfinder is the window you put your eye to before taking a picture. Many modern cameras don't have a proper viewfinder at all, instead requiring you to use the large LCD screen on the back of the camera to compose your shot. That's fine; you don't need a viewfinder for casual photography, as demonstrated by the popularity of smartphone photography.

Do You Need a Viewfinder?

Viewfinders are useful for serious photographers and anyone shooting sports or wildlife, however. First, they block out sunlight and distractions, making it easier to concentrate on your composition. If you're using a telephoto lens (as you would be for sports and wildlife), they make it much easier to hold your camera steady and pinpoint a distant subject.

This picture shows the Sony a5100 (which has an LCD display but not a viewfinder) on the left and the slightly more expensive Sony a6000, which has a viewfinder in the upper-left corner.

Optical vs Electronic Viewfinders (EVFs)

Modern cameras have one of two types of viewfinders, and this can have a significant impact on your photography:

- **Optical viewfinders**. All DSLRs (except the Sony SLT cameras) have an optical viewfinder, the basic design of which dates back to the late 1800's. It really is a primitive design; the camera inserts a mirror between your lens and sensor and it bounces the light into a prism which then bounces the light into your eye. This guarantees that the viewfinder shows what your sensor will see, because it's exactly the same light.
- **Electronic viewfinders (EVFs)**. Mirrorless cameras process the data from the digital sensor and display an image either a large display on the back of the camera or a small, simulated viewfinder. This means that you can see the

effects of exposure compensation. The camera can also supplement the image with histograms, focusing peaking, and other useful data. Because the camera has to process the signal, there is always a very short delay of a few milliseconds. Also, the digital display is less sharp than the real world.

The following three figures show the Canon 70D's optical viewfinder (first) followed by two different views of the Fujifilm X-T1's EVF. As you can see, the X-T1's EVF is bigger, brighter, shows far more information, and overall looks far more modern and polished.



EVFs allows for a much more complex display while looking through the viewfinder, because the camera can add anything it wants over your view, almost like the heads-up display from the Terminator or Robocop movies. For example, the EVF can:

- Display a histogram while you look through the lens.
- Show you the actual exposure that the picture will have, including any exposure compensation you've dialed in.
- Allow you to monitor video recording using the viewfinder.
- Allow you to review the last photo without removing your eye from the viewfinder.
- Reduce or eliminate the viewfinder blackout period DSLRs experience when taking a picture.
- Provide a depth-of-field preview that doesn't darken the viewfinder. Depth-of-field preview on an optical viewfinder is less useful because the viewfinder gets very dark, making it difficult to see.
- Provide 100% viewfinder coverage. Optical viewfinders on less expensive cameras tend to hide very small portions of the edges of the frame.

High-quality electronic viewfinders (such as those in the Olympus E-M1, Fujifilm X-T1, and Panasonic GH4) are superior to optical viewfinders for most types of photography. They're better than real life, allowing you to see in the dark, view the exact effect of any exposure compensation, preview filters (such as seeing in black-and-white), and zoom in for precise focusing. They don't go dark when you take a picture, and you don't have to take your eye away from the viewfinder to review your last shot. You can even use the viewfinder while recording video.

Optical viewfinders seem outdated in comparison (and they are), but they operate at the speed of light, so there's no lag. That makes them superior for sports and wildlife. They also don't require any battery power, so while a DSLR battery can last a week on vacation, my mirrorless cameras with electronic viewfinders are out of batteries in 4-6 hours.

For true DSLRs with optical viewfinders, you can realize most of these benefits by switching your camera to live view mode and looking at the display on the back of the camera. Of course, this requires you to hold the camera away from your face, and therefore is not a perfect substitute for an EVF. DSLR live view displays also tend to be slower and more laggy than a mirrorless camera's EVF.

In practical use, EVFs have some disadvantages when compared to an optical viewfinder. Specifically, the lag, refresh rate, and sharpness (discussed in the next section) are never as good as an optical viewfinder. They also consume far more batteries than an optical viewfinder.

In my opinion, EVFs are so great that they're definitely the future. Whether they're right for you, right now, depends on your subject. You certainly don't *need* an EVF, though they can be nice to have.

Right now, EVFs are not the ideal choice if you shoot action. Combined with the fact that mirrorless cameras have slower focusing systems and fewer telephoto lenses prevents me from recommending mirrorless cameras for sports and wildlife. However, that doesn't stop many photographers from taking great action shots with EVF cameras; they just need to anticipate the action a bit more and perhaps snap a few more frames.

EVF Lag, Refresh Rate, and Sharpness

All EVFs are not created equal. Better quality EVFs look nicer, allow for more precise manual focusing, and enable you to

better track moving subjects.

The three most important criteria for evaluating an EVF are:

- **Lag**. This is the delay between an event occurs in the real world and the time you see it on the viewfinder. All EVFs have some lag because the camera has to process the data from the sensor, but a shorter lag is better. Longer lags can be quite frustrating to use with moving subjects. As an example of the variation in lag, our recent test found the Fujifilm X-T1 had a lag of .005 seconds, the Olympus E-M10 has a lag of .025 seconds, and the Sony a6000 had a lag of 0.046 seconds. In low light, lag can increase substantially.
- **Refresh rate**. Higher refresh rates cause movements in the EVF to be smoother. For example, if you pan the camera sideways with a slow viewfinder, the pan will seem jagged instead of smooth. EVFs measure their refresh rate in frames per second (fps). Fast EVFs, like the Olympus E-M10, have a refresh rate of 120 fps. Slower EVFs might have a 30 fps refresh rate, similar to that of a television.
- **Resolution**. The more pixels in the viewfinder, the sharper the screen. Sharper screens look more like the real world, and can help make manual focusing easier. For example, Olympus gave the high-end E-M1 a 2.36 million dot display, whereas they gave the lower-end E-M10 only a 1.44 million dot display.

A few years ago, lag, refresh rate, and resolution problems could often make EVFs almost unusable on mirrorless cameras. However, all modern mirrorless cameras have EVFs that won't interfere with the picture taking process. If you shoot action, however, it might be worth investing in a camera with a higher quality EVF. Specifically, the Panasonic GH4, Olympus E-M1, and Fujifilm X-T1 have the greatest viewfinders available.

EVFs on Sony SLT Cameras

Sony has been pioneering the use of electronic viewfinders (EVFs) with their SLT/DSLRs (though true DSLRs don't have EVFs, they otherwise function like DSLRs). In theory, this provides the best of both worlds: the phase detect autofocus capabilities of a DSLR with the EVF of a mirrorless camera.

The SLT design reduces the total light reaching the camera's sensor by one-eighth to one-third, requiring cameras with an EVF to use a higher ISO setting or a longer shutter speed to achieve the same exposure.

If you want a DSLR-like design with an EVF, your current options are limited to the Sony a58, a77, and a99.

Viewfinder Placement

All DSLRs have the viewfinder in the upper-middle of the back of the camera, because it must be physically aligned with the lens. Mirrorless cameras could theoretically put the viewfinder anywhere, but they generally position it in the upper-middle (like an SLR) or the upper-left (like a viewfinder camera), as shown in the following picture. If you shoot with your right eye, having the viewfinder in the upper-left is more comfortable, because it doesn't require you to press your nose against the camera back. If you shoot with your left eye, the center viewfinder is more comfortable.

Touch screen

Touch screens allow you to navigate menus by touching the screen, just like you would on your smartphone. Touch screens are particularly useful for choosing an off-center focus point and for quickly zooming in to check focus while reviewing pictures.

A touch screen is a nice feature, and it can definitely improve your workflow. Hand a camera without a touchscreen to anyone under 25, and you'll see them poke at the screen; younger people assume everything should have a touch screen. And they should; touch screens are wonderful.

You definitely can live without a touchscreen. If you want a professional-level camera, you'll have to. Unfortunately, only mid-range cameras currently have touch screens available. For most casual camera buyers, a touch screen should be a requirement.

Autofocusing

Almost any camera will focus on well-lit still subjects with the kit lens, so the casual photographer doesn't need to worry about it.

Focusing becomes a challenge when tracking moving subjects (such as sports and wildlife), when shooting in low-light, and when working with shallow depth-of-field. Telephoto lenses and fast lenses (with f/stop numbers such as f/1.8) have a shallow depth-of-field, which means the eyes of your subject can be in focus, but the background will be very blurry. For more information about depth-of-field, refer to Chapter 4 of Stunning Digital Photography.

Mirrorless vs DSLR

Generally, DSLRs autofocus better than mirrorless cameras (when using the viewfinder). In fact, in our testing, the least expensive DSLRs were better at autofocusing on moving subjects than the most expensive mirrorless cameras, including cameras such as the Sony a6000 and Fujifilm X-T1 that advertise phase-detect focusing. This difference in focusing speed means a low-end mirrorless camera won't be useful for candid portraits, sports, or moving animals. If you're interested in those types of photography, check out DSLRs instead.

Note that mirrorless cameras support both single shot and continuous autofocus modes. However, focusing tends to be so slow that continuous autofocus on moving subjects doesn't work very well. In practice, you'll generally get better results with single shot autofocus.

Different Focusing Technologies

Most modern DSLRs and many higher-end mirrorless cameras feature two different focusing mechanisms:

- **Phase detection**. The quickest way to autofocus, phase detection uses a pair of sensors for each focusing point. With a DSLR, light travels through your DSLR's partially translucent mirror. Behind that mirror, at the exact same distance from the lens as your camera's sensors, are one or more pairs of focusing sensors for each focus point on your camera. Those sensors see slightly a small part of your picture from two slightly different angles. When the view from the two sensors lines up, that part of the picture is in focus and your camera can stop the autofocus process.
- **Contrast detection**. Contrast detection autofocus is much slower than phase detection autofocus, however, contrast detection is more flexible because it can focus on any part of the picture; not just where a focusing point exists. DSLRs can use contrast detection in live view mode, and some support contrast detection autofocus while recording video. Contrast detection examines data from the camera's sensor while adjusting the lens' focus, and by comparing subsequent frames captured from the sensor, can determine whether a focus movement causes the captured image to get more contrasty (indicating more focused) or less contrasty (indicating less focused) at any point on the frame. Therefore, with contrast detection, a focus point can be anywhere in the frame. Most DSLR sensors only provide data at 30 frames per second or 60 frames per second, limiting how quickly the camera can capture subsequent views of the scene while focusing, and thus the overall focusing speed. Therefore, mirrorless cameras tend to have much faster contrast detection autofocus than DSLRs.

DSLRs, and some mirrorless cameras, focus primarily using phase detection autofocus. With a DSLR, any time you're looking through an optical viewfinder, you're using phase detection autofocus.

All modern digital cameras also support contrast detection autofocus. If you're looking at a the live view display on the back of a DSLR, that means the camera's sensor is receiving all the light from the scene, and the camera has moved the mirrors out of the way. Without the mirrors, your camera can't redirect light to the phase detection autofocus sensor. Therefore, it must use the slower contrast detection autofocus instead.

The Canon 70D is one exception to this. Its dual-pixel AF technology provides phase detection autofocus in live view, greatly improving focusing speed when the mirror is up—such as when you're recording video.

Here's a minor technical point about Sony Alpha cameras with Single-Lens Translucent (SLT) mirrors: their mirrors don't move out of the way like a traditional DSLR. Whereas a DSLR uses the mirror to reflect light to both the optical viewfinder

and the phase detection focusing sensors, on a Sony SLT camera, the mirror only reflects light to the focusing sensors; most of the light passes through the mirror to the sensor. This allows the SLT cameras to take advantage of phase detection autofocus at all times, even when taking pictures or recording videos. While those are huge benefits, I still recommend most people choose traditional DSLRs with optical viewfinders.

That's more technical detail than you need to remember, so here are a few key points:

- Phase detection is generally much better than contrast detection, especially for moving subjects.
- DSLRs support phase detection autofocus when you're looking through the optical viewfinder.
- All digital cameras support contrast detection. DSLRs use contrast detection when you're viewing the live view display.
- Phase detection autofocus is limited to specific focusing points, while contrast detection allows you to focus anywhere in the frame.
- Mirrorless cameras that advertise phase detection autofocus only support it when lenses designed for phase detection are used. Currently, very few lenses support phase detection. For example, the Olympus E-M1 supports phase detection autofocus, but not a single native lens is designed for that. The Sony a5100, Sony a6000, and Fujifilm X-T1 all support phase detection autofocus, but only a small handful of lenses are compatible with the system.

How Phase Detect Focusing Works

With most modern lenses, the focusing motor (which physically turns the lens elements to change the focus) is built into the lens. Every other part of the focusing is controlled by the camera body.

All DSLRs, and some high-end mirrorless cameras, use phase detect focusing. When you focus your camera, it looks at the image coming through the lens and then tries to focus a little closer or farther away. Just like you have two eyes in your head, each focusing point in your camera is two separate sensors. When the focus is correct, the image from those two sensors lines up. At that point, the camera stops focusing.

Of course, that's an oversimplified explanation of a really complicated process. Focusing speed and precision is extremely important to portrait, wildlife, and sports photographers, so camera makers do everything they can to make the process as fast as possible. Unless you become a serious sports or wildlife photographer, you really don't need to understand all the nitty-gritty about how different camera bodies autofocus. However, keep reading if you're interested or you just want to understand the lingo.

Every camera body has multiple focus points. There's always one focus point in the center of the image, and several others spread around the frame. Using the focus-and-recompose technique (described in Chapter 4 of Stunning Digital Photography), you only really need the center focusing point. However, the other focus points are useful for action shots where you don't have time to focus-and-recompose.

Not all focus points on a camera are created equal. Typically, the center focus point is the fastest, and the farther you get from the center, the less powerful the focus points are. Common types of focusing points include:

- **Vertical**. Vertical focus points detect contrast by looking up and down an image. Therefore, a vertical focus point would be able to focus very quickly on a shirt with horizontal stripes, but might not be able to focus at all on vertical stripes.
- **Horizontal**. Horizontal focus points detect contrast by looking left and right through an image. They're good at detecting vertical stripes (or any type of vertical contrast), but not great at focusing on horizontal subjects.
- **Cross-type**. Use both vertical and horizontal contrast detection. They can focus on just about anything, as long as the subject is well-lit and isn't a solid color.

It's common for the center focusing point to be cross-type, and focusing points towards the edges of the frame to be horizontal or vertical. However, some cameras, such as the Canon 7D and 70D, use only cross-type sensors.

Sometimes, a focusing point's capabilities depend upon the minimum f/stop number of the lens you're using. For example, the center focusing point might be cross-type with f/2.8 lenses, but only horizontal with lenses of f/4 or higher. There's no practical application for this knowledge; it's not likely to be a significant enough factor to justify spending hundreds or thousands on a different body or faster lens. In practice, you'll use the camera and lenses you have and do the best you can with the focusing it

provides.

Most camera bodies support autofocusing when the lens' minimum f/stop number is f/5.6 or lower. However, some Canon bodies (specifically, the Nikon D4S, Nikon D810, Canon 1DX, and Canon 5D Mark III) support focusing with f/8 lenses on some of their focusing points. This capability is important to wildlife photographers who often use teleconverters to extend the reach of their telephoto lenses, because teleconverters also increase the lens' minimum f/stop number.

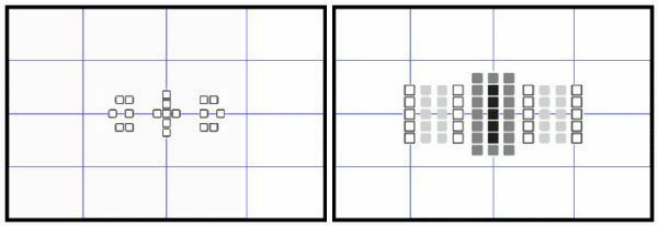
Focus Point Positioning

DSLR manufacturers often advertise the number of focusing points a camera offers, but the number of focusing points is not nearly as important as how they're positioned in the frame. For example, some cameras have all their focusing points clustered in the middle of the frame, which is only useful if the subject will be centered in the frame. If you use the *rule of thirds*, as described in Chapter 2 of Stunning Digital Photography, you'll want your focusing points to be 1/3 of the way through the frame. Only higher-end DSLRs provide that.

Therefore, don't consider a camera with a large number of focus points to be automatically superior to another camera. Instead, pick the camera with the focusing points closer to the edge of the frame.

For example, the Sony Alpha a99 ($2,800) brags about having 102 autofocus points. This is mostly marketing fluff, because it has only 19 autofocus points that will allow you to attain initial focus. The remaining 83 points are only useful for continuing to track moving subjects after you initially focus, and then, only with specific lenses. 19 AF points are plenty, but there's a bigger problem: those 19 AF points are clustered around the center of the frame.

The Canon 5D Mark III ($3,300) has 61 autofocus points, and at a glance, would seem to have an inferior autofocus system compared to the a99. However, comparing the autofocus points that can be used for initial focus on a rule-of-thirds grid, as shown in the following figure, tells a different story. The a99's focus points, on the left, are clustered around the center, requiring you to use the focus-and-recompose technique for every single shot that follows the rule of thirds—and that will be most of your shots. The 5D Mark III's autofocus points reach much farther, allowing you to autofocus on the left or right third of the frame (but still not all the way to the corners, unfortunately).



The Sony Alpha a99's autofocus points (left) are clustered around the center of the frame, which is less useful than the Canon 5D Mark III's autofocus points (right), which are distributed farther across the frame.

I don't mean to criticize the a99 specifically; it's an amazing camera. I spent the first decade of my photography career only using the center autofocus point (combined with the focus-and-recompose technique), so even just a single autofocus point will get the job done. I'm only showing this example because, as you assess different camera bodies, I want you to put less emphasis on the number of autofocus points and more emphasis on how they're distributed across the frame.

Nikon Focusing Motors

For Nikon camera bodies, there's one more factor to consider: whether the body has a focusing motor. Whereas most modern lenses have the focusing motor built into the lens, older Nikon lenses relied on a special motor built into the body to adjust the lens focus. Higher-end Nikon DSLRs still include focusing motors to allow autofocus with these older lenses. Specifically, the following recent Nikon DSLRs have a focusing motor: D90, D300, D7100, D600, D610, D800, D810, D3x, D4, and D4S.

All other new Nikon DSLRs don't have a focusing motor. Therefore, autofocus will work fine with all newer AF-S and AF-I lenses, but you won't be able to autofocus with older AF lenses that require a focusing motor (though you can still use them with manual focus). Fortunately, most of Nikon's current lineup is AF-S. All you'd really be missing out on is autofocusing with their fisheye lenses, but the wide depth-of-field with fisheye lenses makes focusing easy.

Sensor size and crop factor

Video: Crop Factor Part 1 8:01 sdp.io/crop1	

Video: Crop Factor Part 2 37:35 sdp.io/crop2	

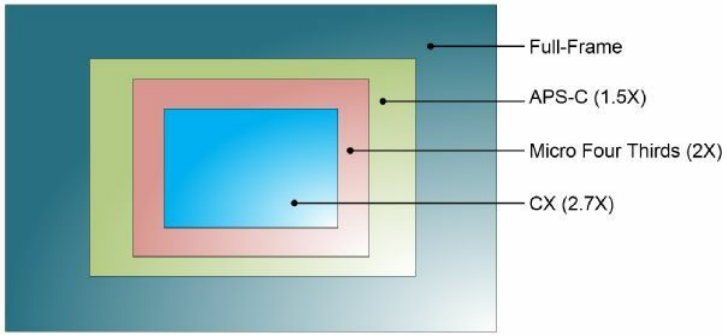
Video: Crop Factor Part 3 25:36 sdp.io/crop3	

Cameras can be divided into several categories by their sensor size. Starting with the smallest, they are:

- **CX**. These tiny mirrorless cameras, such as the Canon EOS M, have the smallest common sensors.
- **Micro four thirds**. These small mirrorless cameras have relatively small 16-megapixel sensors that are capable of producing excellent images when paired with the right lenses.
- **APS-C (Canon APS-C, Nikon DX, Sony Alpha/NEX, Fujifilm: starting below $500)**. The smallest type of DSLR is also a common mid-range mirrorless format, and the right choice for most non-professional photographers. Lenses designed for their smaller sensors are lighter and less expensive than those designed for bigger, full-frame cameras. However, you can also connect full-frame lenses to Canon APS-C, Nikon DX, and Sony Alpha bodies, but when you take a picture, the camera will crop out a smaller section from the center of the lens image. This is known as the crop factor, and it's actually helpful when using telephoto lenses with wildlife or sports. In fact, many wildlife photographers prefer an APS-C or DX camera over their full frame counterparts. Crop factor is discussed in more detail later in this section.
- **Full-frame 35mm (bodies only starting around $1,800)**. Matching the sensor size of 35mm film, full-frame DSLRs require bigger, more expensive lenses. Full-frame DSLRs are the right choice for most professional photographers, but not simply because the sensor is bigger. Instead, I recommend full-frame cameras to photographers because they tend to have more features completely unrelated to the sensor. Additionally, full-frame Canon and Nikon cameras have access to the widest variety of native lenses simply because the formats have been used by professionals for decades. Given the same variety of native lenses, you could get the same photos with smaller sensors, but other formats simply don't have the same variety available, and adapting the lenses always comes with significant penalties.
- **Medium format (bodies only starting at about $15,000)**. Medium-format DSLRs provide professional studio photographers the resolution they need for shooting magazine covers and posters. The 60 megapixel Hasselblad H4D-60 retails for about $42,000, yet it can't take decent indoor pictures without flash, it's too slow for wildlife or sports, and it's too big for most people to carry around (though I often travel with a medium format film camera). For those reasons, most professional photographers use full-frame 35mm DSLRs instead.

The following figure compares a compact camera sensor to a full-frame camera sensor.

The following figure shows the relative sizes of different sensor types along with the crop factor of each. The crop factor is very important to understand when purchasing lenses or even just reading this book.



Crop factor and focal length

Throughout this book and Stunning Digital Photography, I list focal lengths in 35mm equivalent. Therefore, if you want to calculate the equivalent focal length for a compact DSLR, you would divide the 35mm focal length by 1.6 for Canon or 1.5 for Nikon. If you want to calculate the equivalent focal length for a Micro Four-Thirds camera, you would divide the focal length by 2. If you want to calculate the equivalent focal length for a medium format camera, you would multiply it by 2.

For example, a "normal" or "standard" lens sees about the same angle of view as our eyes. On a full-frame camera, the normal view is 50mm. On a compact camera, the normal view is about 31mm, or 50 / 1.6. On a Micro Four-Thirds camera, the normal view is about 25mm, or 50 / 2.

Given this conversion, these three lenses provide similar zoom ranges when attached to the type of camera they were designed for:

- **Micro Four-Thirds**: the Olympus 14-42mm.
- **Compact**: the Canon 18-55mm.
- **Full frame**: The Sigma 24-105mm.

Most of the photography world, including myself, uses 35mm equivalents when discussing focal length just because 35mm has historically been the most popular format. Therefore, if you see an example picture that shows a 200mm focal length, you can bet that it's probably 200mm using the full-frame 35mm format. If you were using a compact DSLR and wanted the same field of view, you would use a 125mm lens, because 200 / 1.6 = 125.

> **Tip:** Big and small sensors can both have very high megapixel counts. However, smaller sensors capture less light because they have less surface area. So, the larger full-frame format will always be better in low-light and produce less noise—but the difference might never be important to you.

Crop factor and aperture

Different sensor sizes change the field of view provided by a focal length. We refer to this as the "crop factor", and it allows us to quickly determine that a 45mm micro four-thirds lens is equivalent to a 90mm full frame lens.

While the crop factor works for determining the field of view, it does not work for determining the depth of field and

background blur that you'll get from any given lens. While camera manufacturers often provide a "35mm equivalent" when describing a lens, they don't tell you that you won't get the same background blur when using smaller lenses, and this has led to many frustrated portrait photographers.

For example, consider two portrait lenses that seem very similar:

- The full frame Canon 85mm f/1.8 ($400)
- The micro four-thirds Olympus 45mm f/1.8 ($400)

Knowing that you double the focal length of micro four-thirds lenses to determine the 35mm equivalent, the Olympus seems to compare favorably to the Canon. You might see portraits taken with the Canon 85mm f/1.8 (such as the following), and assume that you'd be able to achieve similar background blur.

The Olympus can't achieve the same background blur, however, because you must apply the crop factor to the aperture to calculate depth-of-field (and thus background blur). In this example, the Olympus 45mm f/1.8 lens is equivalent to a full-frame 90mm, f/3.6 lens when considering both field of view and background blur.

You can also multiply the depth-of-field by the crop factor. Therefore, a micro four-thirds camera with a crop factor of 2x, has about twice the depth-of-field (and thus half the background blur) of a full frame camera, even after you multiply the focal length by the crop factor. An APS-C sized DSLR has 1.5X to 1.6X more depth of field, or 50-60% less background blur than a full frame camera.

For calculating the shutter speed you'd need in any given lighting scenario, you wouldn't need to multiply the aperture—the Olympus would still have the same shutter speed as a full frame 90mm f/1.8 lens, or any f/1.8 lens, for that matter. However, for portrait work, lenses for smaller sensors have far less background blur. To achieve similar background blur to the Canon 85mm f/1.8, you would need a 45mm, f/0.9 lens, and nothing like that is currently available.

Currently, the best micro four-thirds autofocusing lens for achieving a nice background blur is the Olympus M Zuiko ED 75mm f/1.8 ($830). For calculating background blur, this lens is equivalent to a full-frame 150mm f/3.6 lens. Unfortunately, that doesn't compare favorably to traditional 35mm portrait lenses. My budget full frame portrait recommendation, the Tamron 70-200 f/2.8 ($750), is just as sharp, less expensive, offers much better background blur, and provides a very useful zoom range.

There is one micro four-thirds lens that provides full-frame SLR like background blur in a portrait focal length, but it lacks autofocus, and autofocus is critical when working with short depth-of-field portraiture because people move too much to manually focus on the eye. The *SLR Magic Noktor 50mm f/0.95* is equivalent to a full-frame 100mm f/1.9, and is $1,100.

Let's consider that lens on crop and full-frame DSLRs. On a Nikon DSLR with a compact sensor, it becomes equivalent to a 105-300 f/4.2. On a Canon DSLR with a compact sensor, it becomes equivalent to a 112-320 f/4.5. Only on a full-frame body will you be able to achieve the full potential of the lens' ability to blur the background.

I don't want you to feel bad about purchasing a micro four-thirds or APS-C camera; they're very capable cameras, and background blur is only one aspect of photography. Smaller sensors, and their large depth of field, actually show you much more of a scene, making them ideal for landscapes. There are also other ways to control background blur, including moving your subject further from the background. For detailed information, refer to Chapters 4 and 6 of Stunning Digital Photography.

I hope that highlighting this weakness of smaller sensor designs for portrait work will help push lens manufacturers to offer faster lenses for the smaller sensors. The first manufacturer to give fair treatment to APS-C sized sensors is Sigma, with the Sigma 18-35mm f1.8 lens. When calculating background blur, this lens is roughly equivalent to a 27-52mm f/2.8 lens. It's still

too wide angle to make a viable portrait lens, but it's an amazing lens for general photography with compact sensors, and I'm glad to see Sigma manufacturing faster lenses for smaller sensors.

Crop factor and ISO

You can also use crop factor to estimate the total image noise different sensors will have at a specific ISO. Simply multiply the ISO of the smaller sensor by the crop factor twice:

$$\text{Smaller Sensor ISO} * \text{Crop Factor} * \text{Crop Factor} = \text{Full Frame ISO}$$

Or, to write it another way:

$$\text{Small Sensor ISO} * (\text{Crop Factor})^2 = \text{Full Frame ISO}$$

For example, you can expect ISO 200 on a Micro Four Thirds camera (which has a 2x crop factor) to have similar total image noise as ISO 800 on a full frame camera, because 200 * 2 * 2 = 800. You can expect ISO 100 on a Nikon APS-C camera (which has a 1.5x crop factor) to have similar total image noise as ISO 225 on a full frame camera. The following table gives you estimates of the amount of total noise you can expect from different ISOs and different sensor sizes, given similar sensor technology. That last clause, "given similar sensor technology," is very important, and I'll discuss it further.

Full-frame	APS-C (1.5X)	Canon APS-C (1.6X)	MFT (2x)	CX (2.7X)
64				
100				
200				
225	100			
256	114	100		
400	178	156		
640	284	250	160	
729	324	285	182	100
800	356	313	200	110
1,600	711	625	400	219
3,200	1,422	1,250	800	439
6,400	2,844	2,500	1,600	878
12,800	5,689	5,000	3,200	1,756
25,600	11,378	10,000	6,400	3,512

Some of the table cells are blank because those ISOs are not natively available on modern cameras. For example, the full-frame Nikon D810 supports a native ISO of 64. Theoretically, a Micro Four Thirds camera that supported an ISO of 16 would provide the same total image noise as a full-frame camera at ISO 64. However, no Micro Four Thirds camera supports a native ISO lower than 160.

Therefore, in bright light or studio conditions that allow you to use your cameras lowest native ISO, bigger sensors will provide lower total noise. This isn't because bigger sensors are inherently better, but simply because camera manufacturers haven't yet designed smaller sensors to work with lower ISOs. In the future, a Micro Four Thirds camera with a native ISO of 16 could theoretically compete with the Nikon D810 for studio work.

My calculations are estimates based on the total light gathered by each sensor size at a specific ISO. That means the crop factor math isn't quite perfect, because some sensors are more efficient than others. However, the math is accurate to around $1/10^{th}$ of a stop for most cameras (excluding Canon cameras, which are not as efficient).

The following table compares DXOMark's measured scores for the top-end bodies from popular camera lines. Below the DXOMark score, I show the ISO you would use to achieve the same level of noise as ISO 800 on the Nikon D810 (based on the DXOMark measurements). The ISO 800 Equivalent (total light) row shows the equivalent ISO based on total light gathered (as estimated by the crop factor^2 formula).

	Nikon D810	Sony a7R	Canon 5D Mk3	Nikon D7100	Sony a6000	Canon 70D	Olympus E-M1	Panasonic GH4	Nikon 1 V3

DXOMark Score	2853	2746	2293	1256	1347	926	757	791	384
ISO 800 Equivalent (measured)	800	770	643	352	378	260	212	222	108
ISO 800 Equivalent (total light)	800	800	800	341	341	309	201	201	108
Efficiency vs D810 (stops)	N/A	-0.06	-0.32	+0.05	+0.15	-0.25	+0.08	+0.14	0.00

The last row shows the number of stops the camera over or underperforms the D810 while gathering the same total light. As you can see, differences in sensor technology make very little difference compared to differences in sensor size; even professionals would not notice a difference of less than .2 stops. You'll also notice that Canon's sensors don't perform as well given the same light as sensors from other camera manufacturers.

Estimating total light using the crop factor^2 formula is useful for quickly estimating the noise performance of different cameras. To more precisely calculate the noise performance of specific cameras, check the Sports (Low-Light ISO) rating of the camera on DXOMark.com.

Megapixels

Megapixels describe the picture size a digital camera produces. Usually, the more megapixels a camera has, the better. However, if you're using an unsharp lens (such as a consumer kit lens) then megapixels might not make any difference.

> A *megapixel* is a million *pixels* (picture elements, or more simply, colored dots) that make up a picture. So, a one megapixel picture (about the size you'd see on the web) is made up of a million dots, and an eight megapixel picture (which would make a nice 8x10" print) is made up of eight million dots. To calculate the dots, multiply the width and height of the picture. So, a 1600x1200 picture is about 1.9 megapixels, and a 4000x3000 picture is about 12 megapixels.

The following table puts megapixels and photo resolution in perspective by showing the maximum size you can make a camera's photos while still maintaining clarity. The cameras used range from a camera phone to a professional medium-format studio camera that costs more than a new BMW.

Megapixels	Resolution	Print Size (300 dpi)	Sample Camera
8	3264x2448	8x10"	iPhone 5
12	4272x2848	9x12"	Canon T3
16	4928x3264	11x14"	Nikon D7000
21	5616x3744	12x19"	Canon 6D, 5D Mark III
33	6726x5040	17x22"	Mamiya DM33
36	7360x4912	18x24"	Nikon D810
60	8956x6708	22x30"	Hasselblad H4D-60
200	16352x12264	40x54"	Hasselblad H4D-200MS (still subjects)

You can make a nice 8x10" print with a camera phone. So, why would you ever want more?

- **Bigger prints**. 300 dots per inch (DPI) are ideal for printing. 200 DPI look good, too; the picture won't be quite as sharp, but you won't notice when viewing the picture from a distance. The farther away you are, the lower the DPI you need; I've made billboards with a 6 megapixel camera, and they looked fine because of the large viewing distance. At 300 DPI, you'll need a 15 megapixel camera to make an 11x14" print, a 30 megapixel camera to make a 16x20" print, and a 50 megapixel camera to make a 20x30" print.
- **Cropping**. Those print size estimates assume you use every last pixel. Yet, if you print an 8x10", you'll crop off about 7% of the image because your camera's sensor is a bit wider than an 8x10" print. If you want to rotate an image 90° to crop a horizontal shot to a vertical portrait, you'll lose more than half your megapixels. Cropping a full-body picture of someone to a headshot can reduce your pixel-count by 75%. Having more pixels means having

more cropping flexibility.

- **Noise**. All camera sensors have noise visible when you view a picture at full resolution. Generally, pictures aren't viewed at full resolution, however, the more pixels you start with, the less noise there will be when you share pictures on the Web or view smaller prints.
- **Selling pictures**. Microstock agencies charge more for larger pictures, so higher resolution images can make more money.

There is a downside to larger megapixel counts—bigger file sizes. Bigger files take more space on your memory card and on your computer, and editing your pictures takes longer. However, memory cards and disk drives are cheap nowadays, and most cameras allow you to shoot at a lower megapixel count when you need to.

Many people choose Sony and Nikon cameras over Canon and Micro Four Thirds cameras because Sony sensors (which Nikon uses in their cameras) have higher megapixel counts. For example, many new photographers must choose between the 18 megapixel Canon T5 and the 24 megapixel Nikon D3300.

With 33% more pixels, the D3300 must produce sharper images, right? It can, but the sharpness will be the same for most photographers, because there's another factor: the lens. Both cameras come with a kit lens that's not as sharp as they could be: DXOMark rates them both at about 9 megapixels. Therefore, if you just use the kit lens, both cameras will produce similar details, and you won't even be making use of the T5's full 18 megapixels.

So, if you plan to use only the kit lens, you can safely disregard the difference in megapixels, and instead base your decision on how the camera feels in your hand, focusing speed, price, and other factors.

However, if you plan to replace your kit lens with the incredibly sharp Sigma 18-35 f/1.8 lens (the sharpest APS-C zoom lens available), you will get sharper pictures from either camera. DXOMark rates the Canon T5 with the Sigma 18-35 at 15 megapixels, while they rate the D3300 with the same lens at 17 megapixels. In this example, the D3300's 33% more megapixels produced about 13% more detail.

Here's another comparison: the 24-megapixel Canon 5D Mark III and the 36-megapixel Nikon D800E. When connected to the excellent Tamron 24-70 f/2.8 lens (the sharpest zoom lens available in that range), the DXOMark rates the Canon combination at 18 megapixels of detail. The Nikon combination rates 23 megapixels of detail. In this example, Nikon's 50% more pixels results in 28% more sharpness.

These tests are conducted in ideal conditions. Any sort of camera shake, subject movement, or atmospheric conditions (such as humid air) will further decrease the importance of additional megapixels. However, in our testing with sharp lenses, Nikon's higher megapixel sensors do have noticeably more detail when you use a sharp lens.

Before you decide to buy a high megapixel camera and an expensive, sharp lens, ask yourself whether sharpness and detail will have a noticeable impact on your photography. For most casual photographers, sharpness doesn't matter at all. Most casual photographers only ever share their images online, where people view images at no more than 2 megapixels, and nobody would ever be able to tell the difference between a high megapixel camera with a sharp less and a low megapixel camera with a cheap kit lens. Even if you have a huge 4k monitor and you view the image full-screen, it will only have a resolution of 3840 x 2160, which is about 8 megapixels.

In other words, even the most basic cameras capture far more megapixels than you could ever view online. Rather than spending their budget on expensive cameras and lenses just to get more sharpness, most photographers would be better served by choosing less sharp gear, and setting aside more of their budget for lighting and training.

Consider a portrait photographer with a total budget of about $5,500. He could spend his budget in two ways:

- Buying a 36-megapixel D810 ($3,300) and a Nikon 70-200 f/2.8 ($2,200).
- Buying a 24-megapixel D3300 ($400), a Tamron 70-200 f2.8 ($1,300), a set of four Paul C. Buff Einstein lights with modifiers (about $3,000), and light stands, backdrops, stools, and fans ($800).

Sure, the D810 would produce sharper images, but the extra lights will have more impact on the final picture quality.

Similarly, a landscape photographer with an extra $1,000 in his budget will do more to improve his portfolio by spending the money on a trip to Glacier National Park than he would buying more megapixels and sharper glass.

Megapixels are the last thing most photographers should worry about. Wildlife photographers, however, are an important

exception. Wildlife photographers almost always crop their pictures because they can't get close enough to the animals to fill the frame. Sharpness makes a huge difference on image quality for wildlife photos, too. Therefore, high megapixels and a sharp lens are more important to wildlife photographers than portrait, landscape, or even sports photographers.

High megapixels and noise

Many photographers believe higher megapixel sensors produce noisier images. Often, the exact opposite is true: higher megapixel sensors in Nikon and Sony cameras actually produce less image noise than the lower megapixel sensors in Canon cameras. So, why the confusion?

The lower the megapixel count, the larger the individual pixels (known as photosites). Just like a larger bucket gathers more rain, a larger photosite gathers more light. The more light a photosite gathers, the less noise it will produce in that pixel.

Therefore, since pixel noise is primarily determined by the amount of light a single photosite gathered, lower megapixel sensors have less pixel noise. When photographers compare the noise produced by two sensors, they often zoom in and view images on a pixel-by-pixel basis (1:1). When they do that, they're comparing pixel noise, and lower megapixel sensors will seem to have less noise.

But there's an important difference between pixel noise and total image noise. We only see pixel noise when we compare photos on a pixel-by-pixel basis. In the real world, images are scaled to the size of our display or print, and multiple pixels are blended together. In the real world, we don't notice pixel noise. Instead, we see total image noise.

Total image noise is determined primarily by the total light gathered by the sensor, and the light gathered by each individual pixel makes no measurable difference.

In practice, the higher megapixel sensors from Sony and Nikon actually have less total image noise than the lower megapixel sensors from Canon. In other words, if you take pictures with a 36-megapixel Sony a7R and a 24-megapixel Canon 5D Mark III and make a 20x30" print, the a7R's print will have less visible noise.

Maximum ISO speed and noise

Like film, digital cameras need a specific amount of light to create an image. Just about any camera can take great, noise-free pictures in bright sunlight. When the sun goes behind a cloud, or you move indoors, you'll begin to notice the difference between sensors.

Digital cameras measure their sensitivity to light using ISO. The following table shows common ISO speeds and when you might use them (without flash).

ISO speed	Use
50-200	Outdoors, full sunlight
400	Outdoors, cloudy days
800	Indoors, brightly lit
1600	Indoors, normally lit
3200	Indoors, poorly lit
6400	Indoors, poorly lit
12,800+	Indoors, dark (such as a bar at night)

Higher ISO speeds are one of the greatest features of professional cameras, because they allow you to take photos in dimly lit environments without using a flash or a tripod. At ISO 12,800 and higher, you can hand-hold pictures at night—imagine being able to take pictures of your friends in a restaurant without a flash, or doing night photography without a tripod. Unfortunately, current digital cameras produce so much noise at ISO 6400 and above, that you're still better off using a tripod or a flash and a lower ISO setting whenever possible.

The more serious you are about your photography, the less important high ISO speeds will be. Only the most casual photographer will be happy with photos taken at ISO 12,800 on any camera; the noise in the image would simply be too high to sell the picture for any purpose other than, perhaps, photojournalism. However, high ISO speeds typically produce fine results for online use, such as posting a picture to Facebook. In other words, if you want to be able to take snapshots of your friends in a dim bar and put them online, pick a camera with a high maximum ISO. If you want clean, professional results, even in dark

environments, you'll carry a tripod with you, set your camera to ISO 100, and use a long exposure, so the high ISO won't matter.

Stunning Digital Photography will tell you everything you need to know about choosing the right ISO setting for different situations. For now, understand that one of the most important factors to consider when buying a camera is the noise levels at different ISO settings and the maximum ISO speed. The less noise and higher the maximum ISO speed, the less you'll need that annoying flash.

> A lower-megapixel sensor with low noise can create a picture of similar quality to a higher-megapixel sensor with high noise. For a detailed explanation, read "Contrary to conventional wisdom, higher resolution actually compensates for noise" at http://dxomark.com/index.php/eng/Insights/More-pixels-offsets-noise!.

If you really want to nit-pick the noise your camera's sensor makes, visit http://DxOMark.com. DxO Labs measure the signal-to-noise ratio (SNR) of different camera sensors at different ISO speeds and allows you to compare them. As you'll see if you examine a camera at the site, the SNR is very high at ISO 100 and 200. At ISO 1600 and above, the SNR is very low—reflecting the noisier pictures you'll see at higher ISO speeds.

Minimum ISO speed and noise

Landscape and still life photographers have the opportunity to use a tripod and long exposures, and thus always have the option of using their camera's lowest native ISO. Studio photographers have the opportunity to add as much light as they want, and also use their camera's base ISO. For these types of photographers, high ISO performance doesn't matter, but optimal ISO performance can be very important. You can get the lowest possible noise by using a full frame camera at its base ISO.

Most cameras have a base ISO of 100, and you should use that base ISO whenever possible to take the cleanest pictures. One camera in particular, the Nikon D810, offers an unusually low native base ISO of 64, providing lower noise than is possible on any other camera.

Olympus Micro Four-thirds cameras have a base ISO of 200, and Panasonic Micro four-thirds cameras have a base ISO of 160. Because they have higher base ISOs, their very best image quality is noisier than other cameras. Later, this chapter discusses how the Micro four-thirds sensor size further reduces the total light gathered at the base ISO, meaning Panasonic's base ISO of 200 produces images with about the same noise as a full-frame camera (with similar sensor technology) at ISO 800. For many professionals, that means even the most well-lit shots will be too noisy to use commercially.

Disregard extended ISOs. For example, many cameras with a base ISO of 100 offer an extended ISO of 50. Choosing ISO 50 will not provide better image quality than ISO 100; your image quality will be exactly the same as taking a raw image at ISO 100 and overexposing it by one stop.

Lens and body compatibility

Lenses should be matched to your sensor size. If you have a Canon or Nikon DSLR, use the following table to determine which type of lens to buy for your DSLR.

Sensor Type	Lens Type	Sample Lens
Canon APS-C	EF-S	EF-S 17-85mm f/4-5.6 IS
Canon full-frame	EF	EF 100-400mm f/4-5.6 L IS
Nikon DX	DX	18-105mm f/3.5-5.6G ED VR AF-S DX
Nikon FX	(not indicated)	AF-S Nikon 24-70mm f/2.8G ED

If you have a Canon APS-C DSLR, you can attach a full-frame Canon EF lens. However, the picture will be cropped by 1.6X, which is known as the focal length *multiplier*. Everything will look fine through the viewfinder, but you'll be zoomed in 60% more than you would be with a Canon full-frame camera body. If you're using a wide-angle lens to shoot at 24mm, and the camera uses an APS-C sensor with a 1.6x crop factor, your picture will be at the not-so-wide-angle 38mm (24 x 1.6 = 38).

You cannot use Canon EF-S lenses with a Canon full-frame body. The following table shows Canon body and lens compatibility.

	Canon EF-S	Canon EF

Canon APS-C	Ideal	1.6X crop
Canon Full-frame	Not functional	Ideal

If you have a Nikon DX DSLR, you can attach a full-frame Nikon lens. The picture will be cropped by 1.5X, effectively zooming everything in by 60%. Unlike Canon, you can use a Nikon DX lens on a full-frame Nikon FX camera body—however, because the lens was designed for smaller sensors, your pictures will be at a lower resolution. The following table shows Nikon body and lens compatibility.

	Nikon DX	**Nikon Full-frame**
Nikon DX	Ideal	1.5X crop
Nikon FX	62% smaller pictures	Ideal

For most people, crop factor isn't a concern at all. Just buy lenses designed for your camera, or use the lens that came with your camera. You can still get ultra-wide-angle lenses—for example, Canon makes a 10-22mm lens that is equivalent to a 16-35mm full-frame ultra-wide-angle zoom. Sites such as bhphotovideo.com have separate categories for DSLRs with *Canon APS-C* or *Nikon DX* sensors and *full-frame DSLRs*, so as long as you're aware of your sensor type, you can get the right lens.

The only types of lenses that Canon and Nikon don't create for compact cameras are the professional super-telephotos. Canon and Nikon both make 600mm f/4 super-telephoto lenses for full-frame cameras only, because if you're willing to spend $8000 on a lens, you're probably also willing to spend a few more bucks on a full-frame DSLR. You can still use these super-telephotos or any full-frame lens on a DSLR with a crop factor, but you'll be losing part of the image projected by the lens, meaning you're paying for something you aren't using, and carrying around unnecessary glass.

Frames per second and buffer

Frames per second (FPS) measures how fast your camera can take pictures when it is in continuous shutter mode. The slowest DSLRs can take shots at about 3 FPS, whereas professional models designed for sports can shoot at up to 14 FPS.

If you plan to shoot sports or wildlife, FPS will be very important to you, and it might be worth spending more to get a camera with a higher FPS. Moving from 3 FPS to 6 FPS doubles the number of shots you take when the action is occurring. In sports, that increases the chances of you capturing a stunning shot with a fleeting expression, or recording that split-second where the baseball meets the bat. In wildlife, it means you're more likely to get a shot of the flying bird with its wings just at the top of a flap.

Basically, higher FPS increases the overall quality of your action shots by increasing the chances that you capture that split-second where the light, expression, and pose are perfect. However, even 3 FPS is enough for the casual sports and wildlife photographer. If you aren't serious about shooting sports or wildlife, FPS really doesn't matter at all, and it shouldn't be a factor in your buying.

Buffer size is another factor that is closely related to FPS. When you take a picture, your camera first copies the picture from the sensor to a temporary, but high-speed buffer. From the buffer, the picture is then copied to your permanent, but much slower, memory card. Therefore, your camera's advertised FPS can only be achieved while there is room in the buffer. When shooting RAW, the buffer can fill up quite quickly. For example, the Canon 5D Mark III shoots at about 6 FPS. However, the buffer can be completely filled after about 2 seconds of continuous shooting, and future shots will be much slower to capture.

Using a faster memory card can extend your continuous shooting by allowing the buffer to unload images faster, allowing you to take many more shots before the FPS slows down. With the Canon 5D Mark III and a high-speed UDMA 7 CF memory card, the camera can shoot continuously for about 6 seconds (instead of the usual 2) before the buffer is full.

If you plan to shoot long bursts of action and use RAW, research two factors:

- The number of continuous shots the camera can capture before the buffer is full.
- The performance of different memory cards with your camera.

Buffering isn't typically a problem with JPG files, because JPG files are much smaller, and therefore consume much less of the buffer.

Maximum shutter speed

Different camera bodies have different maximum shutter speeds. For example, the base model Nikon D3100 has a maximum shutter speed of 1/4000th of a second, whereas the top-end Nikon D4 has a maximum shutter speed of 1/8000th of a second.

Very few people will ever need to shoot above 1/4000th of a second. 1/4000th is sufficient for any sports or wildlife, even hummingbirds. Even if you have the need to go faster, it's difficult to get enough light to allow your camera to exposure at that shutter speed without using a very high ISO. Therefore, the maximum shutter speed isn't a factor for most photographers.

Controls and ergonomics

One of the most underrated features of a camera body are the buttons and controls. Lower-end cameras tend to have fewer buttons. Instead, they allow you to change settings by navigating a menu. Higher-end cameras have more buttons dedicated to specific settings, allowing you to more quickly change a setting.

For example, the Canon T3 lacks an exposure compensation dial. If you want to adjust the exposure compensation, you need to navigate the menu system. Higher-end cameras have a dedicated dial that you can quickly adjust with your thumb.

Even though adding controls can make a photographer much more efficient, very few people spend extra money on a higher-end camera just for the additional buttons. Instead, you can think of more advanced controls as a free bonus included with the higher-end cameras.

Display

Like the controls, the display is a very important part of a camera—yet not a feature that's likely to push you to spend hundreds or thousands of extra dollars on a camera.

In a nutshell, larger, brighter, higher-resolution displays are better, because they give you a better preview of your picture. However, you're not likely to choose between two cameras just based on the display quality.

Some cameras have articulating displays which flip up, down, out, or some combination of those. Flip up and flip down displays are quite useful; they allow you to hold the camera up high over your head, or down low to the ground, making unusual compositions much easier. Flip out displays can be rotated towards the front of the camera so you can see yourself when you're taking a self-portrait, which helps you frame yourself in the picture.

However, articulating displays take up space and reduce the durability of a camera because they're difficult to weather seal. For that reason, articulating displays are a feature on lower-end cameras that is missing from higher-end cameras. If an articulating display is important to you, you might be forced to choose a less expensive camera to get that feature.

Built-in flash

Less expensive DSLRs have a built-in flash above the lens that pops up when needed. DSLRs designed for professionals don't have a built-in flash. This seems counter-intuitive, and like articulating displays, it's one of the few examples of a feature that's cut from higher-end cameras.

I like having a built-in flash on a DSLR. Sure, it never looks as nice as an external flash, but it's convenient because it's always with you, and it's better than nothing. So, why don't pro DSLRs have a built-in flash? Because pros tend to plan ahead and carry a larger flash when th ng is more important to pros than convenience, and a pop-up flash is difficult to make weather proof.

If you get a pro-level DSLR without a built-in flash, be prepared to also buy an external flash and carry it with you. If you get a consumer-level DSLR with a built-in flash, you should also be prepared to buy an external flash, because the built-in flash is quite ugly.

USB Charging

For those of us planning to travel with our camera, USB charging is a helpful feature. With USB charging, you can charge your

camera's battery using a USB cable, exactly like you charge your smartphone.

This means you don't have to travel with a battery charger. It also means that you can connect your camera to a USB battery charger, such as the RavPower model shown below, and charge your camera when you don't have access to a power outlet. Look for a model that supports 2A (2 amp) charging; this will charge your devices faster. I always keep a battery charger and several USB cables in my backpack while traveling.

Of course, USB charging is more of a concern for cameras with shorter battery life. My DSLRs can often go an entire week with a fresh battery. On the other hand, my mirrorless cameras typically run out of batteries around 2:30pm on a day of casual travel photography.

Currently, only some Sony and Samsung mirrorless cameras support USB charging.

Sound

Lower-end cameras, such as all camera phones and most P&S cameras, can be completely silent when they take a picture because they don't have a physical shutter. DSLRs have both a mirror and a shutter that needs to open and close with every picture you take, and that process makes a distinct thud or clanking sound.

If you're shooting portraits or landscapes, the sound will make no difference to you whatsoever. However, if you're a photojournalist, a wedding photographer, or if you shoot candids or wildlife, the mirror/shutter noise can be extremely important to you. Imagine needing to photograph a funeral without disturbing the grieving, or waiting hours for a fox to come out of its den, only to have it started by the noise from your first shot.

Some newer DSLRs feature quiet or "silent" modes (which typically aren't really silent). On some bodies, the mode is only available when shooting in live view mode, so you can't be looking through the viewfinder when you use it. However, many new bodies reduce sound when using the viewfinder by moving the mirror a bit slower, reducing the noise it makes as it bangs open or closed.

Unfortunately, nobody seems to document the sound levels of different cameras in any standardized way. However, if you search the web for specific models and the words shutter and sound, you can often find users who have done testing on their own.

If low sound levels are really important to you, you might look instead to mirrorless cameras. If your DSLR really must be silent, consider buying a camera muzzle or a sound blimp from *http://www.soundblimp.com/*.

Sync Cord

Pro-level DSLRs tend to have a sync cord connector, which is a very old standard for firing external flashes and studio lighting when you take a picture. Basically, you plug a special cable called a sync cord into your camera and your flash system, and when you take a picture, the flash fires.

If your camera doesn't have a sync cord, don't fret, because you can always trigger external lights by using a wireless remote attached to your flash shoe. I use the PocketWizard system.

Weather proofing and durability

Another factor that distinguishes consumer-level DSLRs and lenses from pro-level DSLRs and lenses is weather sealing. Every button and opening on your camera is an opportunity for dust, sand, and moisture to enter the camera. Pro-level DSLRs are designed to better keep these elements out, resist rain, and to survive more serious bangs and drops.

Most consumers don't need that extra weather proofing and durability. If it's raining, the consumer will probably just leave their camera at home. If you're a photojournalist or a sports photographer, you don't have that option; you need to take pictures regardless of the conditions.

Camera designers often have to choose between convenience and weather-proofing. For consumer cameras, the designers choose convenience. For professional cameras, the designers choose weather-proofing. That's why consumer cameras have some cool features that professional cameras lack, such as articulating LCD screens and built-in flashes. Pro cameras also need to have every button and opening weather sealed, which adds weight and can make the buttons a little less friendly to use.

Metering

Metering is the process your camera uses to determine how bright or dark to auto expose a scene. In the days of film, metering was exceptionally important, because you wouldn't know if you exposed a shot properly until after you developed your film. With digital cameras, you can instantly glance at your photo and immediately know whether the camera over- or under-exposed the shot, and make any adjustments necessary. Additionally, if you shoot raw, you can often adjust the exposure one or two stops in either direction and still get excellent results. So, even if your camera does expose the picture incorrectly and you can't adjust exposure compensation and re-shoot, you can still get a great result.

For those reasons, metering systems are much less important than they were in the film days. Nonetheless, higher-end cameras tend to have more advanced metering systems that will more accurately expose complex scenes, such as heavily backlit scenes. The differences between metering systems aren't significant enough to influence your camera choice, however.

Memory card slots

Modern digital cameras use two different memory card standards:

- **SD**. SD cards are small and inexpensive. They also tend to take longer to write pictures to.
- **CF**. CF cards are larger and more expensive than SD cards. They tend to be faster, allowing you to take more pictures in a short amount of time when using continuous shooting.

Lower-end cameras tend to use SD cards, whereas higher-end cameras use CF cards. Higher-end cameras often have multiple slots for memory cards.

In the Canon world, the mid-range Canon 6D has one SD card slot. The higher-end Canon 5D Mark III has two slots: one SD and one CF. The top-end Canon 1D X also has two memory card slots, both CF.

Having two cards slots is useful; you can have twice the capacity and if one card fails, you have a backup. Having a second slot can also allow you to keep an Eye-Fi card in one of the slots, providing Wi-Fi connectivity for quickly previewing pictures on a computer or mobile device.

GPS

Some newer cameras have built-in GPS tagging capabilities, automatically adding location information when you take pictures. While not particularly useful for professional purposes, GPS tagging is both useful and fun for personal pictures. Applications such as Lightroom can display your pictures on a map, allowing you to see exactly where they were taken, and allowing you to browse pictures by the location.

Only a handful of DSLRs, including the Canon 6D, have built-in GPS tagging. If your camera does not have GPS capabilities, you can often purchase an overpriced accessory to add GPS tagging to your camera, such as the Canon GP-E2 ($250) or Nikon GP-1 ($200). A less-expensive alternative is to use a smartphone app to record your location, and then synchronize your location on your PC. Search your smartphone app store for geotagging to find supported apps.

Wi-Fi and Ethernet

Wi-Fi is the wireless network technology that laptops and tablets use to connect to the Internet. Some new cameras, including the Canon 6D and Canon 70D, support Wi-Fi. Ethernet accomplishes the same thing as Wi-Fi, but uses a cable and transfers images quite a bit faster. Top-end cameras such as the Canon 1D X allow you to connect them to a network using an Ethernet cable. Additionally, you can buy overpriced accessories to connect other camera bodies to wired and wireless networks.

Connecting your camera to a network is useful for tethering, which is the process of instantly transferring images from your camera to a PC or mobile device. Tethering is useful in several different scenarios:

- A casual photographer could transfer a picture to their smartphone so they could post it on Facebook without going back to their computer.
- A photojournalist could transfer a picture of a crime scene directly to their editor.
- A portrait photographer could transfer pictures to a PC so the customer can preview them immediately.
- A fashion photographer could allow an art director to examine the pictures as they're taken on a computer display so the art director could provide immediate feedback.
- A commercial photographer could examine the pictures on a PC to verify that the images meet the stringent quality requirements.

Most casual photographers won't ever need to tether their camera, but many professional photographers do need to tether. If your camera has Wi-Fi or wired Ethernet built-in, you can install an app on your mobile device, PC, or Mac to receive and preview pictures you take in real-time. If your camera does not have tethering built-in, you can probably add an Eye-Fi or Transcend SD Wi-Fi card and accomplish the same thing. If your camera takes CF memory cards, you can use the SD Wi-Fi cards with an inexpensive adapter.

Wi-Fi can also provide remote viewing and remote control of your camera, as shown in the following picture. While cool, I have yet to find a practical application for this.

X-sync speed

As described in "Flash Sync Problems" in Chapter 5, flash synchronization problems can lead to uneven lighting in a flash picture. Most name-brand flashes support high-speed sync with the manufacturer's camera bodies, allowing you to use flash at any shutter speed. Thus, if you use a name-brand flash, you can usually shoot at any shutter speed with anybody (but check your flash's manual to be sure).

When using a flash that does not support high-speed sync, such as a generic flash, you cannot use shutter speeds faster than your camera's X-sync speed. The X-sync speed is the fastest shutter speed that the camera's shutter fully exposes the entire sensor at once, giving the flash the opportunity to fire and illuminate the entire picture evenly.

I don't know that anyone has ever chosen one body over another based on the X-sync speed. It's only important if you want to use a generic flash with faster shutter speeds, and even then, X-sync speed on camera bodies varies very little. For example, most of the Canon lineup has an X-sync speed of 1/200th, but the top-end camera, the Canon 1DX, has an X-sync speed of 1/250th. The Sony NEX-6 has an X-sync speed of 1/160th. The Nikon D40 has a remarkably fast X-sync speed of 1/500th, due to a rather special shutter mechanism, but the more expensive D4 has an X-sync speed of only 1/250th.

While I don't expect you to choose a camera body based on its X-sync speed, portrait photographers using studio lighting or generic flashes in bright sunlight should be familiar with their camera's X-sync speed. In bright sunlight, you often need to use shutter speeds that might be faster than your camera's X-sync speed. If that's the case, and your flashes don't support high-speed sync, you will need to watch your shutter speed closely and verify that your flash is evenly illuminating the frame.

The PocketWizard wireless camera triggers have a clever feature called HyperSync that can actually increase a camera's X-Sync speed. For example, the Canon 50D normally has an X-sync speed of 1/250th, but when using a PocketWizard FlexTT5 and the HyperSync feature, can achieve X-sync speeds of 1/400th. For more information about wireless flash triggers, refer to the Flash Buying Guide later in this book.

Image stabilization

Image stabilization, as discussed in *Chapter 6, "Lens Buying Guide,"* allows you to hand-hold pictures with slower shutter speeds. Sony has it built into the body, Canon and Nikon put it into the lenses. In practice, the difference doesn't matter, and shouldn't sway your buying decision.

All Sony DSLR bodies have sensor shift image stabilization built-in, and any lens you use it with will be automatically stabilized. In theory, this would allow you to save money on lenses, because you wouldn't need to buy lenses with the image stabilization feature. In practice, Sony lenses aren't any less expensive than Nikon and Canon lenses. For example, the image stabilized Sigma 70-200 f/2.8 is the same price for all three systems, about $1,250. Sony's 70-200 f/2.8 costs about the same as Canon's image stabilized lens ($2,000), despite being significantly less sharp.

Anti-aliasing filter/Optical low-pass filter/Blur filter

Most camera sensors have an anti-aliasing (AA) filter, also known as an optical low-pass filter or blur filter. Basically, this filter blurs the image just a bit before your sensor captures it, helping to reduce aliasing and moiré.

Aliasing and moiré are odd-looking artifacts in images, and they're definitely something you want less of in your photos. However, most photos wouldn't have any of those artifacts, anyway. You see aliasing and moiré primarily in tight patterns, such as brick walls and checkered or striped clothing.

Most of the time you don't need the AA filter, but it's always in front of your sensor, very slightly reducing sharpness. A few cameras, including the Nikon D800, provide the option of removing the AA filter by choosing an alternate model (the D800E). A few other cameras, including the Nikon D3300, simply do not include an AA filter.

Most photographers should never bother thinking about whether or not they want an AA filter. Simply choose the camera that's right for you based on more important features, and use the sensor as-is. Technical photographers who are looking for the ultimate in sharpness can seek out one of the few bodies without an AA filter, specifically, the entry-level Nikon D3300 or professional Nikon D800E.

Image processing

Newer DSLRs have very powerful processors capable of performing really complex photo manipulation in-camera. This has allowed camera manufacturers to add HDR and panorama features to cameras.

These features are convenient for the casual user, but they're not for enthusiasts because they give you very little control over how the processing is done, and often, they simply do a terrible job of processing the pictures. Therefore, I would never

recommend one model over another because of the presence of HDR, panoramas, or other image processing special effects. Instead, I would recommend the photographer do the processing on their computer.

Hacked firmware

Perhaps one of the more important software considerations is the availability of third-party extensions through hacked firmware. No camera manufacturer actively supports installing your own software on your camera; they treat cameras more like an appliance than a smartphone or PC. However, some crafty individuals have created custom software extensions for popular cameras.

The most widely used of these hacks is *Magic Lantern*, which is available for many recent Canon DSLRs. Magic Lantern adds a variety of cool features, including:

- A built-in intervalometer for taking pictures on a scheduled basis, such as every 30 seconds, which is useful for image stacking or creating a time-lapse video.
- More flexible bracketing than is normally available.
- HDR video, which is useful for filming in situations with a great deal of contrast.
- On-screen audio meters and zebra striping when recording video.

The extra features are nice, but they're not terribly user-friendly. Magic Lantern has its own, separate user interface, and it's quite complicated. So, it's not for the average user, but for the more technical among us, the added features can make such a significant difference that you might choose a camera compatible with Magic Lantern over a competing model.

While a handful of hacks are available for Nikon cameras and other manufacturer's cameras, none offer anywhere near as many capabilities as Magic Lantern.

Video

Starting with the Nikon D90 and the Canon 5D Mark II, video capabilities in DSLRs have been an important factor to many users. In fact, many commercial TV shows and movies use DSLRs for some tasks, rather than traditional video cameras, because of the relatively low cost, their great low-light capabilities, and the shallow depth-of-field they can achieve. I shot all of the videos for this book using DSLRs.

Nonetheless, DSLRs are never as good for shooting video as a good video camera. DSLRs are designed to be briefly held against your face, not held at arm's length or supported on your shoulder for an extended period of time. DSLR lenses have focusing and zoom systems designed for still photos, rather than video, preventing you from focusing or zooming smoothly. DSLR image stabilization and focusing systems tend to be so noisy that they ruin on-camera audio.

Some DSLRs are better than others for video. If video is an important part of your buying decision, and you want to make professional-level videos, here are the features to look for:

- **Video quality**. Most new DSLRs can record 1080p video, which provides incredible sharpness. However, there are subtle differences in the quality of the video that professional videographers will notice, such as chromatic aberration (odd colors at the edges of objects), tearing (a strange artifact that occurs when you pan a DSLR), moiré (bizarre effects in tight patterns and grids), and aliasing (jagged edges that should be smooth).
- **Frames per second**. Most video is filmed at 30 frames per second (fps), and 30 fps is standard for all video playback. However, cameras that support higher fps allow you to use video editing software to create slow motion video without dropping the frame rate. If a camera supports 60 fps, you could play it back at half speed using the standard 30 fps rate. Many DSLRs also support 60 fps rates, but only at lower resolutions, such as 720p. Some cameras support very fast frame rates. The Sony A99, in particular, is capable of recording at 1080p and 60 fps.
- **Maximum video length**. Due to technical limitations, some cameras will only record for a limited amount of time, such as 12 minutes. After that time, you have to manually restart recording. This is important to anyone who plans to record a long event, especially if you plan to leave the camera on a tripod. For Canon cameras, adding the Magic Lantern firmware hack can allow the camera to record longer than its typical limits.
- **Low light recording**. One of the advantages of using a DSLR for video is that their sensors are better at recording in low light than typical video cameras. Some DSLRs are better in low light than others, and every DSLR's video

gets very noisy in dark environments.

- **Autofocus while recording**. There is exactly one DSLR that has usable autofocus while recording: the *Canon 70D with an AF-S lens*. It smoothly changes focus when you touch the LCD, and looks great when being played back. No other DSLR is particularly good at autofocusing while recording; the focusing will be slow, jerky, and disturbing to watch. You're better off stopping recording, refocusing, and then restarting. Serious videographers buy expensive focus pulling equipment and hire a second person just to control the cameras focus. Nonetheless, for casual shooting, you might want to choose a DSLR that supports autofocusing while recording. Sony SLT cameras excel at this, because their translucent mirrors allow continuous autofocus while filming video.
- **Articulating display**. An articulating display is very useful for video, because it allows you to hold the camera high or low while still watching the display. If a camera does not have an articulating display, you can probably attach an external monitor, as described in the "HDMI out" bullet point below.
- **Audio input**. DSLRs have terrible microphones. For all but the most casual video, you will want to use an external mic. While it's possible to record your audio to an external device, such as a Zoom H4n, it's much more convenient to record the audio from an external mic directly to your DSLR. Look for a DSLR with a mic jack. If stereo audio is important, verify that the camera supports stereo input; some only support mono input.
- **Manual audio levels**. If a DSLR does have a mic jack, make sure you can manually control the audio levels. Some DSLRs automatically adjust the mic levels, which can lead to unpredictable and difficult-to-edit sound.
- **Headphone jack.** If sound is important to you, your cameraman should be monitoring the audio using headphones to ensure the mics are working properly. Most DSLRs do not offer a headphone jack, but some do.
- **HDMI out.** The display on the back of your camera is too small for serious videographers. Additionally, it might not be easily visible when holding the camera high or low. Therefore, many DSLR videographers attach a larger, external LCD camera monitor to the camera. I use the Lilliput 5DII-H camera monitor.
- **Uncompressed/clean HDMI output**. Modern DSLRs cannot record uncompressed or raw video. Instead, the camera processes the video before saving it to the memory card. Serious videographers working in studio environments often want to record uncompressed video to an external computer, both for image quality and to make the workflow more convenient; if you record video directly to a computer, a technician can edit the video as it records, and doesn't have to copy video files from the memory card later.
- **Availability of video-friendly lenses.** Video-friendly lenses tend to support image stabilization, and smooth, silent focusing and aperture adjustments. Of particular note are the Canon STM lenses which are great for video, but your options are currently very limited: the only DSLR zoom lens is the EF-S 18-135mm f/3.5-5.6, which only works with Canon APS-C DSLRs, and is only suited for amateur video.

Right now, Canon cameras are considered the best DSLRs for recording video. The Canon 5D Mark III is widely considered the best DSLR for video recording, while a used Canon 5D Mark II with the Magic Lantern firmware provides the best value. However, unless you have professional requirements, any DSLR will do.

Chapter 4: Lens Features

If you're buying your first DSLR and you're buying a kit with a lens, skip this section and come back when you've run into the limits of the current lens. Your kit lens is perfect while you're still getting comfortable using your camera.

A lens shapes incoming light and focuses it on your camera's sensor. The lens is the single biggest factor in image quality—even more important than the sensor. The lens helps determine how close you can zoom to your subject, how sharp and contrasting your pictures are, how fast your camera focuses, how nicely the background is blurred, and when you need to use flash.

Lens mounts and sensor sizes

Make sure you buy lenses that match your camera mount. Canon, Nikon, and Sony each have different mounts, and require lenses built for their mount. You can buy third-party lenses from Sigma and Tamron, just be sure they're made for your camera type. The description for third-party lenses will say something like, "for Canon SLRs" or "for Nikon SLRs."

Here's where it gets confusing: Canon and Nikon both sell camera bodies with different sensor sizes: compact and full-frame. Full-frame lenses are designed for use with the larger full-frame sensors, so the lenses themselves are much larger.

Canon lens varieties

The Canon lens mount is known as EOS. Originally introduced in 1987, all recent Canon lenses and bodies use the all-electric EOS mount. However, that doesn't mean that all EOS lenses and bodies will work together.

Within the EOS DSLR family, Canon has two lens varieties:

- **EF**. Lenses designed for full-frame Canon DSLRs, such as the 5D, 6D, and 1D families. Like the full-frame camera bodies, EF lenses are designed for more professional purposes. Canon uses the "L" designation for professional lenses, and all L lenses are also EF lenses.
- **EF-S**. Lenses designed for compact Canon DSLRs, which are everything except the 5D, 6D, and 1D families.

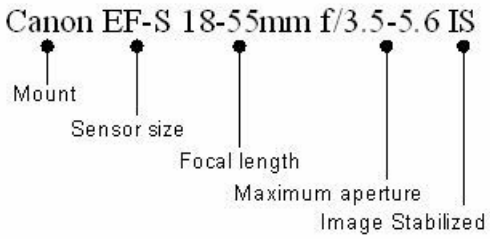
If you have a full-frame Canon DSLR, such as a 5D, 6D, or 1D, you can only use EF lenses. You cannot use EF-S lenses.

If you have a Canon compact DSLR, such as a T2, T3, T4, 7D, Rebel, Kiss, or anything with more than two numbers in the name (like 60D or 600D), you should choose Canon EF-S lenses whenever possible. Canon EF-S lenses are optimized for the compact sensor.

However, if you have a Canon compact DSLR, you can use EF lenses. However, it's rarely the right choice. Because EF lenses are designed for use on a full-frame sensor, your compact DSLR sensor only records the middle of the image. Basically, using an EF lens on a compact DSLR is like zooming in 1.5 times (for Nikon) or 1.6 times (for Canon). It also means you're spending more money and carrying around a heavier lens than you can take advantage of.

For those reasons, I don't recommend using EF lenses with Canon compact DSLRs to casual users. More serious compact DSLR users will probably need to buy full-frame EF lenses for portraits, sports, and wildlife, however, and the $100 Canon 50mm f/1.8 lens, also known as the "fantastic plastic" or "nifty fifty" is a great choice for any camera.

Lens descriptions are filled with numbers and acronyms that are baffling to all but the most hardened photographers. Here's a typical Canon APS-C lens description diagramed:



For this lens, every part of the description is important:

- “Canon” means it’s designed for Canon SLRs. You can’t use it on a Nikon SLR.
- “EF-S” indicates a lens designed for Canon APS-C DSLRs with a smaller sensor size. You cannot use EF-S lenses on full-frame Canon cameras.
- “18-55mm” is the effective focal length. Because EF-S lenses have a 1.6X crop factor, the zoom range is equivalent to 29mm-88mm on a full-frame camera.
- “f/3.5-5.6” is the maximum aperture. Because the description lists a range of apertures, the lens is a variable aperture lens that changes the maximum aperture throughout the zoom range. Therefore, the maximum aperture is f/3.5 when zoomed out to 18mm, and f/5.6 when zoomed in to 55mm.
- “IS” is an acronym that means Image Stabilization, which reduces camera shake.

A typical Canon full-frame professional lens adds a couple of elements to the description:

Because the sensor size is “EF”, rather than “EF-S”, the lens is designed for full-frame cameras. If you use it on an APS-C camera, multiply the focal length by 1.6X to create an effective focal length of 38-168mm. The “L” means it’s an expensive professional lens. The “USM” can be ignored; it’s just an acronym for Ultrasonic Motor--Canon’s quiet and fast focusing motors from the late 1980s.

Nikon lens varieties

Nikon’s current lens system, the F-mount, was introduced in 1959. Because it was introduced so much earlier than Canon’s, the original design relied on mechanical linkages between the body and lens to support focusing the lens and changing the lens aperture. These 50 year old design elements are still present on many Nikon lenses.

Considering how much has changed about photography in the last 50 years, it’s fairly remarkable that you can use many of the 400 F-mount lens from the last 50 years on your modern DSLRs (though you probably won’t want to). With that said, there are countless compatibility issues between old lens and new bodies, and between new lenses and old bodies, that you should refer to the manuals included with your newer equipment before trying anything.

Like Canon, Nikon’s F Mount system has separate lens varieties for compact and full-frame cameras:

- **FX**. These lenses are designed for full-frame Nikon DSLRs, such as the D600, D700, D800, D3, and D4. Like the full-frame camera bodies, FX lenses are designed for more professional purposes.
- **DX**. These lenses are designed for compact Nikon DSLRs, which are everything except the D600, D700, D800, D3, and D4 families.

Either type of lens can be used on any Nikon body. However, if you have a full-frame Nikon, you will definitely want to choose FX lenses. If you use a DX lens on a full-frame camera, you will only be using a small part of the camera’s sensor, losing a great deal of detail.

If you have a compact Nikon DSLR, you can use either type of lens without serious penalty, however, you should choose DX

lenses whenever possible. FX lenses will be unnecessarily large, heavy, and expensive, because their design is optimized for a full-frame sensor, and your compact sensor will only capture the center of the image from the lens. Using an FX lens on a DX camera is like zooming in 1.5 times, so a wide-angle lens becomes a standard lens, and a standard lens becomes a telephoto lens.

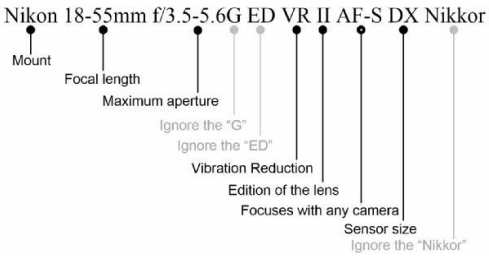
For those reasons, I don't recommend using FX lenses with Nikon compact DSLRs to casual users. More serious compact DSLR users will probably need to buy full-frame FX lenses for portraits, sports, and wildlife, however, and the $100 Nikon 50mm f/1.8 lens, also known as the "fantastic plastic" or "nifty fifty" is a great choice for any camera.

In addition to understanding DX and FX lenses, you also need to understand AF and AF-S lenses:

- **AF-S**. Most new Nikon lenses are the AF-S variety, which includes a focusing motor in the lens. AF-S lenses autofocus with all modern Nikon DSLR cameras.
- **AF**. Many older Nikon autofocus lenses don't have an autofocus motor. Instead, they rely on an autofocus motor built into the camera body that links to the lens when the lens is mounted on the camera.

The following photo of a Nikon D7000 shows the autofocus motor linkage in the lower-left corner of the lens mount:

Here's a typical Nikon lens description diagrammed. Nikon lenses tend to have much more complex descriptions than Canon lenses, because Nikon makes more of an effort to maintain lens compatibility with older film cameras:



The useful information is:

- "Nikon" and "Nikkor" mean that it's designed for Nikon SLRs.
- "18-55mm" is the effective focal length. Because DX lenses have a 1.5X crop factor, the zoom range is equivalent to 29mm-88mm on a full-frame camera.
- "f/3.5-5.6" is the maximum aperture. Because the description lists a range of apertures, the lens is a variable aperture lens that changes the maximum aperture throughout the zoom range. Therefore, the maximum aperture is f/3.5 when zoomed out to 18mm, and f/5.6 when zoomed in to 55mm.
- "DX" indicates a lens designed for Nikon DX DSLRs with a smaller sensor size. You can use DX lenses on full-frame FX Nikon cameras, but you'll get a smaller picture.
- "II" means that this is the second edition of the lens.
- "AF-S" means the lens has a focusing motor built-in and can autofocus on camera bodies that don't have a built-in focusing motor, including the D40, D3000, D3100, D3200, D5000, D5100, and D5200. If you have one of those bodies, be sure you buy AF-S lenses. You can use non-AF-S lenses, but you will need to manually focus.
- "VR" is an acronym that means Vibration Reduction, Nikon's version of Image Stabilization, which reduces camera shake.

Notice that I've asked you to ignore several parts of the description:

- "G" after the aperture indicates that the lens isn't completely compatible with some very old film cameras that lack aperture control on the camera body.

- “ED” means that extra-low dispersion elements are used in the lens—Nikon’s now outdated attempt to indicate lens quality.
- “Nikkor” is simply Nikon’s lens branding; Nikkor just means it’s a Nikon lens, which we already knew.

You might see other acronyms in Nikon lens descriptions, all of which you can ignore:

- “D” after the aperture dates back to 1992, and it indicates compatibility with very outdated camera features.
- “IF” or “IF-ED” indicates that the lens uses internal focusing, which means the focus ring won’t spin when you auto-focus.

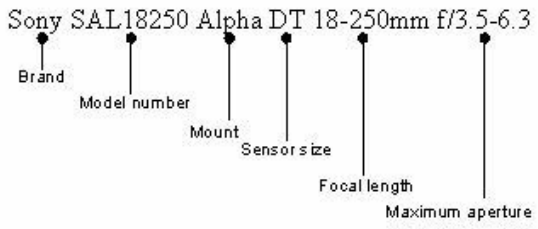
Sony lens varieties

The Sony Alpha’s A-type bayonet mount dates back to 1985, when it was introduced by Minolta. In 2006, Sony bought Minolta, and designed their new camera bodies to work with the Minolta A-mount system. As a result, new Sony DSLRs work with many Minolta lenses from the last 30 years, and vice-versa. Compatibility isn’t always 100%, so check your camera’s documentation and search the Internet to determine whether any given combination will give you the features you need.

Like Canon and Nikon, Sony makes lenses optimized for cameras with compact sensor, as well as full-frame lenses. Those lenses designed for cameras with compact sensors use the DT designation, which stands for Digital Technology. Like Nikon (and unlike Canon), you can you DT lenses on full-frame bodies, but you should avoid it whenever possible.

In the current Sony DSLR lineup, the a99 is the only full-frame camera. Therefore, if you have any other Sony body (the a58, a65, or a77) you should buy DT lenses whenever possible. If you have an a99, be sure to avoid DT lenses.

Here’s a typical Sony lens description diagrammed:



The useful information is:

- “SAL18250” is the model number. SAL is an abbreviation for Sony Alpha, and then they simply add the focal lengths together. It’s convenient that Sony does this, making it easier to casually identify different lenses, without needing to write out the full (and very long) name. The high-end Sony lenses (G and Zeiss Alpha) have a model number that ends in G or ZA.
- “DT” indicates a lens designed for Sony Alpha DSLRs with a smaller sensor size. You can use DT lenses on full-frame Sony cameras, but you’ll get a smaller picture cropped from the center of the frame.
- “18-250mm” is the effective focal length. Because DT lenses have a 1.5X crop factor, the zoom range is equivalent to 27mm-375mm on a full-frame camera.
- “f/3.5-6.3” is the maximum aperture. Because the description lists a range of apertures, the lens is a variable aperture lens that changes the maximum aperture throughout the zoom range. Therefore, the maximum aperture is f/3.5 when zoomed out to 18mm, and f/6.3 when zoomed in to 250mm.

You might see other acronyms in Sony lens descriptions:

- “G” refers to high-end lenses, much like Canon’s “L” series.
- “ZA” refer to “Zeiss Alpha”, a product of Sony’s partnership with Carl Zeiss, a maker of prestigious lenses. ZA lenses are designed and built by Sony, but Zeiss approves the designs to verify the lenses meet the Zeiss’ quality standards. These high-end lenses are priced from $1,000-$2,000.
- “SAM” (Smooth Autofocus Motor) and “SSM” (SuperSonic Motor) refer to specific types of focusing motor. SSM is better than SAM, but don’t let that factor alone change your purchasing decision.
- “ED” refers to Extra-low Dispersion. Ignore this.

- "E," "E-Mount," or "NEX" refers to lenses designed for Sony's mirrorless cameras, rather than their DSLRs. You can't use these lenses on an Alpha DSLR, but you can use the Alpha lenses on the NEX cameras with an LA-EA1, LA-EA2, or LA-EA3 adapter.
- "OSS" (Optical SteadyShot) refers to lenses that have image stabilization built-in.

Micro four-thirds lens varieties

Unlike the other major brands discussed here, micro four-thirds isn't a company—it's a standard that many different companies (including Olympus and Panasonic) create bodies and lenses for. Unlike Canon, Sony, and Nikon, the micro four-thirds brand only has a single sensor size. This makes choosing lenses much easier, because any micro four-thirds lens will work without worrying about cropping.

Aperture

Aperture, measured in f/stops, is the most important quality of a lens. Lenses with lower f/stops are heavier and cost more, but they focus faster, blur the background better, and let you hand-hold the camera in less light. To understand the cost difference, compare Canon's three commonly used 50mm lenses. Each lens is one f/stop faster than the previous, passing twice as much light to the sensor:

- Canon 50mm f/1.8: $100
- Canon 50mm f/1.4: $350
- Canon 50mm f/1.2: $1,500

As you can see, doubling the light roughly quadruples the cost. Size and weight also increase, especially with telephoto lenses. These three lenses are each one f/stop faster than the previous:

- Canon 400mm f/5.6: $1200, 2.8 lbs.
- Canon 400mm f/4: $5,800, 4.3 lbs.
- Canon 400mm f/2.8: $7,200, 11.8 lbs.

For professionals, the extra cost and weight is worth it. If you're an amateur, I'd recommend starting with an inexpensive lens at the focal length you need, and upgrading only when you're frustrated with the maximum aperture—you can usually sell lenses for close to their original cost, so the risk is minimal.

For information about how to use aperture creatively, read Chapter 4 in *Stunning Digital Photography*.

Variable Apertures

Most consumer zoom lenses have a *variable aperture*, which means the maximum aperture when zoomed in is smaller than the maximum aperture when zoomed out. You can recognize variable aperture zoom lenses because their name has two f/stop numbers listed, such as "f/4.0-5.6."

For example, the Canon PowerShot SD950 P&S camera has a zoom lens with a focal length of 7.7-28.5mm and a maximum aperture of f/2.8-f/5.8. That means at its widest angle (7.7mm) the maximum aperture is a respectable f/2.8. However, when zoomed in to 28.5mm, the maximum aperture is f/5.8—requiring more than *four times* more light than f/2.8.

The smaller aperture when zoomed in means your camera will have a harder time focusing and shutter speeds will be much slower. Handholding telephoto lenses requires faster shutter speeds, meaning many of your telephoto pictures will be shaky.

So, should you always avoid lenses with variable apertures? Not necessarily, but you should understand the limitations. Variable aperture lenses are much less expensive to make than constant aperture lenses. For example, the variable aperture Canon 28-135mm f/3.5-f/5.6 lens above is about $430, but the constant aperture Canon 24-105mm f/4.0 lens costs more than twice that.

Focal length

Telephoto lenses have a narrow field of view, allowing light from a very small area in front of you to the sensor, and blocking

all other light. Wide-angle lenses focus light from a much broader area.

Wide-angle lenses have short focal lengths, and telephoto lenses have longer focal lengths. When photographers talk about focal lengths, they always measure them in millimeters (mm), and they usually discuss them in full-frame 35 mm equivalents—even if the sensor isn't 35mm sized. If you have a compact camera, divide the 35mm focal length by 1.6 (for Canon) or 1.5 (for Nikon).

The table below shows common full-frame 35mm and on a compact camera focal lengths and how you might use them. Most lenses are *zoom lenses*, which cover a range of focal lengths. If a lens doesn't zoom, it's called a *prime* or *fixed focal-length* lens.

Full-Frame Focal Length	Compact Focal Length	Typical Usage
8mm	5mm	Fish-eye views that distort the world around you.
16mm	10mm	Super wide-angle views for photographing nearby large objects, such as buildings in narrow streets.
24mm	15mm	A wide-angle view good for photographing groups of people indoors.
35mm	22mm	A moderately wide-angle view good for landscape photography or photographing a single person indoors.
50mm	31mm	Called the "normal" lens, the field of view is roughly equivalent to how the human eye sees.
85mm	53mm	A good focal length for photographing individuals outdoors, where you might stand farther from the person.
120mm	75mm	A moderate telephoto view good for portrait work, photographing children and pets at play, and photojournalism.
200mm	125mm	A telephoto view for headshots and close-range sports such as basketball.
400mm	250mm	A super telephoto view good for larger animals, such as deer or bear. 400mm is perfect for zoos and sports with larger fields, such as football.
800mm+	500mm	An extreme telephoto view used for birding, long-range sports, and spying on celebrities.

The descriptions in the table give a general idea of common uses for different focal lengths, but you can always move closer to or farther from a subject, allowing a wide-angle lens to be used for wildlife, or a telephoto lens to be used for landscape work. There's nothing to stop you from taking a picture of a bear with a 50mm lens, except, perhaps, the bear—you'd have to be about four feet away to fill the frame.

> **Tip:** Big telephoto lenses are expensive. If you see a cheap telephoto lens with a focal length of more than 400mm (250mm on a compact camera), it's probably a mirror lens. Mirror lenses are cheap for a reason: quality is low, there's no autofocus, and light blurred in the background (known as *bokeh*) takes on some really weird shapes.

To give you a sense for different focal lengths, the following sequence of pictures covers a range of 17mm to 400mm with a full frame camera (11mm to 250mm with a on a compact camera camera).

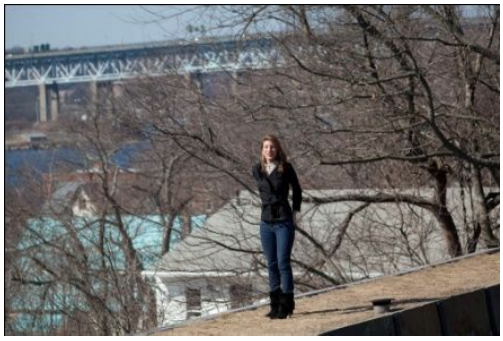
17mm full frame, 11mm APS-C, 8mm micro four-thirds

24mm full frame, 15mm APS-C, 12mm micro four-thirds

50mm full frame, 31mm APS-C, 25mm micro four-thirds

100mm full frame, 62mm APS-C, 50mm micro four-thirds

200mm full frame, 125mm APS-C, 100mm micro four-thirds



400mm full frame, 250mm APS-C, 200mm micro four-thirds

Zooms vs. Primes

Zoom lenses can change their focal length. *Zooming out* feels like moving away from a subject, showing you a more wide-angle perspective and allowing you to see more of the background. *Zooming in* feels like moving towards a subject, showing you a more telephoto perspective and hiding more of the background.

Prime lenses have a single, fixed focal length. If you want to make your subject larger in the frame, you either need to change lenses, or move closer to your subject.

The reality is, zoom lenses give you more options. If you use primes and you're doing travel photography, you might pack 14mm, 35mm, and 50mm lenses. What happens when the best framing for a shot requires 24mm? Zooms allow you to pick the perfect focal length.

Also, zooming to change focal length allows you to control the background, something you can't do when you move closer to or farther from your subject. For more information about how you can use zoom lenses to control the background in your pictures, refer to Chapter 2 in Stunning Digital Photography.

Zooming also changes the proportions of your subject. This is critical in portraiture, where using a wide-angle lens gives your subject cartoonishly large features, while using a telephoto lens gives your subject smaller, more flattering features. For detailed information, refer to Chapter 6 in Stunning Digital Photography.

Of course, you can change your focal length using prime lenses—but you have to change the entire lens. That also means that you need to carry multiple lenses with you. Prime lenses do have several key advantages, though:

- They are smaller and lighter than zooms.
- They tend to be "faster", which means they have a smaller minimum f/stop number, providing faster focusing, faster shutter speeds, and nicer background blur.
- They tend to be much sharper than zooms at a similar price.

I think everyone's general purpose lens should be a zoom. However, all camera manufacturers make an excellent and inexpensive 50mm f/1.8 prime lens, often known as the "nifty fifty" or "fantastic plastic." That's the lens I'd grab if I needed to take pictures in a dimly lit environment, such as a bar, without a flash. While my professional portrait lens recommendation is a 70-200 f/2.8, they start at around $760. You can achieve a similar effect using the much less expensive 85mm f/1.8, which starts at less than half the price of the zoom.

Ultimately, zoom lenses are superior for casual and candid amateur pictures, and fast-paced professional work (such as weddings). Prime lenses are better for carefully planned photos. Prime lenses are also the best choice for low-light and action photos, such as concerts, wildlife, and some sports, because the prime lenses tend to let in far more light.

Different types of zooming

Zoom lenses change focal length in three different ways:

- **Circular zoom**. Turn a ring on the lens clockwise or counter-clockwise to mechanically adjust the lens' optical elements. This is the most common method of zooming, and in my opinion, it's by far the best.
- **Push-pull zoom**. Some telephoto lenses, such as the Canon 100-400mm L IS, are push-pull zooms. Instead of turning a ring to zoom, you push the lens in and out. This allows you to zoom and manually focus at the same time. It takes a little getting used to, but it works fine.
- **Power zoom**. With power zooming (also known as motorized zooming), the zooming is controlled by a motor in the lens. Power zooming is standard on P&S cameras and a common feature on mirrorless lenses, but it's uncommon on DSLRs. Power zooming is slower than other types of zooming, which makes it less-than-ideal for photography. However, the smooth motion of power zooming makes it an excellent choice for video. Power zooming can also allow for one-handed operation.

Focusing Speed

While the camera body contains the sensors and logic to focus an image, the lens impacts the focus speed in two ways:

- For most lenses, the lens contains the electric motor that turns the lens elements. The faster the motor is, the faster the camera can focus. Some motors are louder than others, too, and a quiet autofocus system is nice.
- Lenses with small maximum f/stops, such as f/2.8, allow more light to reach the camera's autofocus sensors. Therefore, an f/2.8 lens will focus much faster than an f/5.6 lens, especially in low-light.

Other than focus speed, consider whether a lens offers full-time manual focusing. Higher-end lenses allow you to adjust the focus even when the lens is set to auto-focus, which can be convenient for fine-tuning. Less expensive lenses require you to flip a switch to manually focus the lens.

Focusing Distance

All lenses have a minimum focusing distance. If you're closer than the minimum focusing distance, the camera will hunt for focus for several seconds, and then give up. All you can do is to move farther from the subject and re-focus.

To get great close-up pictures, however, you'll need a true macro lens. Unfortunately, because true macro lenses are always prime, they aren't good general-purpose lenses. My advice: wait until you get frustrated with your primary zoom because you can't focus close enough, and then add a 100mm or 150mm macro lens to your collection. Read the *Macro Equipment* section for more information on close-up photography.

Sharpness

Some lenses are razor-sharp, while other lenses always produce pictures that are a bit blurry—even when the subject is in-focus. As a general rule, the more expensive, heavier, and larger the lens, the sharper it will be. To get a more objective comparison of the sharpness between two lenses you're considering, just search the Internet—the photography community examines the sharpness of all new lenses.

> **Tip:** Prime lenses are usually sharper (and lighter, and cheaper) than zoom lenses. However, many professional zoom lenses are as sharp as the best primes. Either way, I prefer the flexibility of zoom lenses.

Please don't obsess about lens sharpness, though. Most lenses are *just fine*, and your technique is much more important than the lens' optical quality. Read Chapters 4 and 5 of Stunning Digital Photography to improve the sharpness of your images without buying a more expensive lens.

Contrast

Consider the following two unedited pictures of Chelsea in natural lighting, backlit by a window. The first is severely washed-out because the inexpensive lens diffracts the bright light across the entire picture. The second, taken with a DSLR and professional-quality lens, is high-contrast and sharp. Not all pictures will show this severe of a difference; backlit pictures are particularly challenging for inexpensive cameras.

Image Stabilization

Image stabilization helps to prevent shaky shots by counteracting the movement of your hands. Basically, image stabilization lets you hand-hold your camera when you would otherwise need a tripod. Image stabilization gives you two or three stops more hand-holding capabilities, meaning you can use a shutter speed four to eight times slower without creating a shaky picture.

I can't recommend image stabilization enough. If your budget allows for it, it's the single most important feature on any lens. Image stabilization will save you countless blurry shots, allow you to use lower ISO settings (and thus reduce the noise in your pictures), and allow you to focus more on composition and lighting than camera settings.

If you're shooting moving subjects, such as animals or sports, image stabilization becomes less important because you will need to use a faster shutter speed to prevent motion blur, and that faster shutter speed will also eliminate camera shake. Image stabilization still helps, but if you plan to shoot flying birds, a 400mm or 500mm lens without image stabilization can still get the job done.

Though they all have similar effects, image stabilization is known by different names depending on the camera manufacturer:

- **Canon and Fuji**: Image Stabilization (IS)
- **Nikon**: Vibration Reduction (VR)
- **Sony**: SteadyShot
- **Sigma**: Optical Stabilization (OS)
- **Tamron**: Vibration Compensation (VC)

For Nikon and Canon, image stabilization is built into lenses. For Sony and most other brands, image stabilization is built into the camera body and automatically works with all lenses. I always choose image stabilized camera bodies and lenses when I have the choice—though it's not particularly important (nor generally offered) on wide-angle lenses. Image stabilization is also not required when using a high shutter speed, such as for sports photography or when photographing flying birds, though it does make it easier to look through the viewfinder.

For more information about camera shake, refer to Chapter 4 of Stunning Digital Photography. For more information about the causes of blurry pictures, refer to Chapter 5 of Stunning Digital Photography.

Mirror lenses

Mirror lenses, such as the Rokinon 500mm f/6.3 (shown here), Rokinon 800mm f/8, and Polaroid 500mm f/6.3, seem to offer incredible value for the money. These lenses each cost about $190 dollars, whereas the Canon 500mm lens costs over $10,000. The mirror lenses are also less than one-third the length and weight, making them easier to carry.

Yet, even with a 98% discount, no professionals and very few amateurs use mirror lenses. Why not?

- **Manual focus**. Mirror lenses cannot autofocus, making them useless for moving wildlife. You can still use them for stationary subjects, but focusing can quickly become annoying.
- **High minimum f/stop number**. Mirror lenses have a high minimum f/stop number, which means they don't allow as much light in as other lenses. This requires you to either use a much longer shutter speed (if your camera is on a tripod) or a much higher ISO (which increases noise in the picture). Also keep in mind that the real f/stop number is probably higher than what the lens manufacturer advertises; some mirror lens manufacturers exaggerate this number.
- **Fixed aperture**. Almost all mirror lenses have a fixed aperture, preventing you from choosing a higher f/stop number to increase the depth-of-field.
- **Lack of image stabilization**. While most low-cost telephoto lenses don't have image stabilization, combined with the high minimum f/stop number, this will require you to either use a tripod or use a very fast shutter speed to prevent camera shake.
- **Donut bokeh**. Out-of-focus parts of a picture taken with a mirror lens have an unusual "donut" look to them, just like the shape of the lens' front element. People make a big deal out of this, but I actually don't think it's too disturbing.

- **Low contrast**. The mirror reflections reduce contrast in the photo, so pictures are a bit washed-out. You can improve this with some processing, as described in Chapter 5.

The need to manually focus, combined with the shallow depth-of-field of all telephoto lenses and the fast shutter speed required to prevent camera shake, means that you almost always need to use mirror lenses with a tripod. Some people do take hand-held photos of still subjects in bright daylight, but it's challenging.

In a nutshell, you get what you pay for. Usually, you'll get better overall images by cropping photos taken with an inexpensive telephoto zoom (such as a 75-300mm zoom) than by using a mirror lens. While they're inexpensive, it's still a waste if you can't get pictures that you're happy with.

If you do get a mirror lens, don't go too inexpensive. Models costing less than $150 will give you terrible image quality.

Bokeh

Bokeh (pronounced Bo-kay or Bo-keh) is the Japanese word for the appearance of out-of-focus parts of your picture. Often, the term is used simply to mean a blurry background, but that's not quite accurate, because you can have a very blurry background with either good or bad bokeh.

Usually, you'll only notice the difference between good bokeh and bad bokeh in specular highlights; those bright lights in out-of-focus areas. The most striking example are out-of-focus city lights, but you'll often see good or bad bokeh by looking at bright leaves with sun reflecting off of them.

The average person looking at a picture will never notice bokeh. I've never had a client, personal or commercial, complain about bad bokeh. Only photographers and videographers notice bokeh. If you're taking pictures to please other photographers or videographers, this might be a consideration—otherwise, I don't recommend spending more money just to change the shape of out-of-focus specular highlights.

For an example of the difference between good and bad bokeh, watch the following comparison video of the Sigma 50mm f/1.4 Art lens (which has amazing bokeh) vs. the Canon 50mm f/1.8 (which has lousy bokeh).

Video: Sigma 50mm f/1.4 Art Review

18:59

sdp.io/s50review

Video support

For stationary, tripod mounted videos (like most of those I've created for this book), just about any lens will work for video. However, if you plan to use your DSLR as a family video camera, you should consider how well the lens supports video. Keep in mind these factors:

- **Quiet image stabilization**. Image stabilization is very useful for handheld video, and the image stabilization systems designed for still shots work remarkably well. However, most of them make an awful clicking sound that the on-camera mic will record. If you need image stabilization that's not recorded by the on-camera mic, consider the Canon's STM series of lenses.
- **Smooth zooming and focusing**. Most lenses don't focus or zoom all that smoothly; as you turn the dials, they're a bit jerky. That's fine for still photos, but it looks awful during video. Look for lenses that have particularly smooth video and focus rings. If you plan to use the on-camera microphone, also look for lenses that are quiet while focusing, such as the Canon STM lenses.
- **Motorized zoom**. Some mirrorless camera lenses have motorized zooms, which provide much smoother zooms than are possible with a traditional zoom ring. No DSLR lenses have motorized zooms.

- **Parfocal (constant focus while zooming)**. If you plan to zoom while filming, look for parfocal lenses that maintain their focus during zooming. Most consumer lenses need to be re-focused after zooming, which will cause your video to become blurry if you zoom in on a subject. Currently, this limits you to very few lenses: Canon 17-40mm f/4, Canon 16-35mm f/2.8, Canon 70-200mm f/2.8 (without IS), Nikon 17-35mm f/2.8, Nikon 24-70mm f/2.8 AF-S, Nikon 70-200mm f/2.8 VR Mark I, Panasonic micro four-thirds 7-14mm f/4, and Olympus four-thirds 11-22mm f/2.8-3.5. Other lenses are not truly parfocal, but they might be close enough for video use, including the Canon 24-105mm L IS (one of the most popular video lenses).
- **Breathing**. Most photography lenses "breathe", which means the image zooms slightly when you refocus. To test this, put your camera on a tripod and point it at something with detail, like a bookcase. Manually focus near and then far, and watch the edges of the frame to see if objects are moved in and out of the frame while you refocus. It's not a problem for amateur videos, but it's a factor to consider when assessing a lens for serious video production use.

The Canon STM lenses are designed to be used with video, but currently your options are limited to the EF-S 18-55mm f/3.5-5.6 IS STM, the EF-S 18-135mm f/3.5-5.6 IS STM (both for compact DSLRs with the smaller APS-C sensor), the EF-S 55-250 f/4-5.6 IS STM, and the EF 40mm f/2.8 STM (for all Canon DSLRs). These lenses support smooth, silent autofocusing, image stabilization to reduce shakiness in handheld video, and electromagnetic diaphragms to smooth adjustments to the aperture while filming. Note, however, that the 18-135mm is not a parfocal lens, so if you zoom, you'll also need to refocus.

Teleconverters

Teleconverters cost between $125 and $500, and they're a relatively inexpensive way to ir al length and get closer to wildlife or sports. However, they're not a good investment for most photographers.

Teleconverters connect between your lens and your camera body, increasing the focal length and minimum f/stop number by 1.4x or 2x. For example, if you were to connect a 1.4x teleconverter to a 70-200mm f/2.8 lens, the lens would function as a 98-280mm f/4 lens. Connect a 2x teleconverter to the same lens, and it would become a 140-400mm f/5.6 lens.

Teleconverters work by capturing the center part of the image as it passes between your lens and your camera, and then spreading that center part of the image across the entire sensor. Essentially, it's exactly like cropping to the center half or one-quarter of your picture. However, because teleconverters work by taking half or one-quarter of the light from your sensor and spreading it across the entire sensor, they have some rather nasty side-effects (described in more detail in the sections below):

- Teleconverters drastically reduce the light coming in, requiring you to use a slower shutter speed or a higher ISO. With living subjects such as sports or wildlife, using a slower shutter speed isn't an option, requiring you to use a higher ISO, thus increasing the noise in your picture and degrading image quality.
- Teleconverters slow down autofocusing, and in most cases, will completely prevent your camera from autofocusing. I never recommend using teleconverters unless your lens has a minimum f/stop number of f/4 or lower.
- Teleconverters reduce the sharpness of an image. Unless you are using a professional-quality lens, the final image won't show any more detail. If you are using a professional-quality lens, you can often get more detail from distant subjects by using a teleconverter.
- Teleconverters narrow your field of view, which makes wildlife photography more challenging. It's hard enough to keep a flying bird in view with a 500mm lens. Add a 1.4x teleconverter, and it becomes about twice as hard to keep the bird in the frame.

However, if you have a professional telephoto lens with a minimum f/stop number of f/4 or lower, and you shooting a faraway subject a teleconverter can produce more detailed images than simply cropping a picture taking without the teleconverter. One good example of this is astrophotography; if you're taking pictures of the moon or other faraway objects, a teleconverter will show more detail than you would get by cropping your pictures.

Using a 1.4x Teleconverter

When using a 1.4x teleconverter, you'll lose the ability to autofocus unless:

- You're using a lens that has a minimum f/stop number of f/4 or lower, OR
- You have a Canon 5D Mark III, Canon 1 series, Nikon D600, Nikon D800, or Nikon D1-D4. With the Canon 5D Mark III and 1 series, you will be limited to the center focusing point. With the D600, you will be limited to the 7 center focusing points. With the D800, you will be limited to 11 autofocus points. With the Nikon D4, you can use any focusing point, but you should limit yourself to the center 9 to provide more reliable focusing.

Additionally, a 1.4x teleconverter blocks half the light from reaching your lens. Even if your camera can autofocus with the teleconverter attached, it will be much slower, and might be too slow to keep up with moving subjects.

I only recommend using a 1.4x teleconverter with the following lenses:

- 70-200 f/2.8
- 70-200 f/4
- 300mm f/2.8
- 300mm f/4
- 400mm f/2.8
- 400mm f/4
- 500mm f/4
- 600mm f/4

Notice that those are all telephoto lenses; you shouldn't use teleconverters with wider angle lenses. Instead, simply buy a telephoto lens.

If you have a full-frame camera, you might consider using a camera with a compact (crop/APS-C) sensor instead. The smaller sensor provides a 1.5x or 1.6x increase in focal length, and often provides greater detail than a similar full-frame camera. For example, I often use a Canon 7D compact camera instead of a much more expensive Canon 5D Mark III for photographing wildlife, because the 1.6x crop of the 7D captures more detail in faraway subjects.

Using a 2x Teleconverter

When using a 2x teleconverter, you'll lose the ability to autofocus unless:

- You're using a lens that has a minimum f/stop number of f/2.8 or lower, OR
- You're using a lens with a minimum f/stop number of f/4, and you have a Canon 5D Mark III, Canon 1 series, Nikon D600, Nikon D800, or Nikon D1-D4. As described in the previous section, you will be limited to fewer focusing points.

Additionally, a 2x teleconverter blocks three-quarter of the light from reaching your lens. Even if your camera can autofocus with the teleconverter attached, it will be much slower, and might be too slow to keep up with moving subjects.

I only recommend using a 2x teleconverter with the following lenses:

- 70-200 f/2.8
- 300mm f/2.8
- 400mm f/2.8

Focus Breathing

With many zooms, the closer you focus, the shorter your focal length is. This is easier to experience than to explain.

With any zoom lens (but especially a telephoto zoom), manually focus to infinity, and zoom all the way out to the most telephoto setting. Look through the viewfinder at a door frame with the edges of the door near the left and right edges of the frame. Then, manually focus closer and closer until your lens is at its minimum focusing distance. If your lens exhibits focus breathing, the edges of the door frame will seem towards the center of the frame.

Basically, as you focus closer, you also zoom the lens out to a wider angle, even if you don't adjust the zoom. Because of focus

breathing, zooming and focusing are always linked, even on many prime lenses.

This isn't a problem with your lens. In fact, most zooms exhibit focus breathing to some extent. Some primes do, too, though it tends to be more severe with zooms than with primes.

For example, I strongly recommend a 70-200 f/2.8 zoom lens for portraits. To maximize the background blur and compress the facial features, a portrait photographer will zoom all the way to 200mm. However, when the photographer is focused close enough to the model to take a headshot, the maximum zoom on a 70-200mm lens is actually about 150mm.

To put that another way, a 70-200mm lens only zooms to 200mm when it's focused at a distant subject. When focused on something close, the maximum focal length is typically closer to 150mm.

Focus breathing isn't typically a program for photographers. However, it can be an issue with some professional videography. Imagine a scene where the director wanted to change focus from a subject in the distance to a nearby subject. If you were to change the focus while filming using a lens that exhibited focus breathing, the lens would also seem to be zooming to a wider angle, which could be noticeable in the video and distracting.

For still photography, however, you can simply adjust your focal length or distance to the subject to get the composition you need. The one time focus breathing becomes a problem for still photographers is when performing focus stacking. If you perform focus stacking with a lens that exhibits focus breathing, you will need to compose the picture with the lens focused at the most distant part of the subject. As you take a series of pictures and focus closer with each picture, the lens (even if it's a prime lens) will seem to zoom out to a wider angle. If you were to compose your picture focused on the nearest part of the subject, the lens would zoom in and crop your picture more than you wanted. For more information about focus stacking, refer to Chapter 12 of Stunning Digital Photography.

Chapter 5: Flash Features

Light is the single most important element in a photo, and flashes are the most portable way to control light. While many photographers swear by natural light, I love my flash. A bounce flash can fill a room with natural-looking light, allowing you to create noise-free images in dark environments. Outdoors, you can use fill flash to create flattering lighting without getting that overexposed "flash" look.

Every portrait and real estate photographer should have at least one flash, and serious photographers will own several that they trigger remotely. However, choosing the right flash can be really complicated. The low-end models will quickly frustrate many photographers, and the high-end models cost more than many camera bodies.

In this buying guide, I'll list the current flash models for Nikon, Canon, and Sony flashes, along with my recommendations. If you want to better understand the different flash features available so you can make a more educated buying decision, the rest of this guide gives you an overview of flash features found on different models.

Video: Buying a Flash

8:28

sdp.io/BuyingFlash

Recommended features for different types of photography

If you have an unlimited budget, it never hurts to buy the most expensive, fully-featured flash. Then, you'll be prepared for every situation. Most of us have a limited budget, however, and every dollar we can save on a flash could be put towards a nice tripod, lens, or other accessory more likely to improve our pictures.

Here are the features that you absolutely need for common types of flash photography:

- **General candid family pictures**: TTL metering, tilt bounce head
- **Weddings and events**: TTL metering, tilt & rotate bounce head, external battery pack support
- **Posed portraits with on-camera flash**: Tilt & rotate bounce head
- **Sports**: TTL metering, high-speed sync
- **Real estate**: Tilt & rotate bounce head
- **Off-camera flash (for use with multi-light setups)**: Tilt & rotate bounce head, manual controls, optical slave or other wireless control, audible ready notification

These features are described in more detail later in this section.

Brand

Most people shouldn't buy a Nikon, Canon, or Sony flash. They're wildly overpriced and most people will never use most of the sophisticated features.

Instead, I recommend most photographers buy a generic flash that supports TTL metering and has manual controls and a bounce head, such as those by Yongnuo. They typically cost less than a third of the name brand models.

Here's the catch: the generics aren't as good as the Canon and Nikon models. They simply don't have as much testing and engineering, so they're never quite as reliable, and you might have to manually tweak the power output more often. If you're a professional photographer, especially a wedding photographer, you can't take the very slight risk that one might flake out while the bride walks down the aisle. Some of the generic models lack features that might be important to you, such as TTL, built-in wireless support, and high-speed sync.

However, for most of us (including most professionals), a generic flash is the best value. Because of their low prices, you can buy several and use them in multi-light setups (and also have a backup if one dies), and if you ever decide you need the official Canon or Nikon flash, they'd still make an excellent second flash for off-camera use, so your small investment won't be lost.

The remainder of this section will discuss these features in more detail, and at the end of the section, I'll recommend specific generic and name brand models with different feature sets.

Output

Some flashes are more powerful than others. A flash with more power allows you to illuminate subjects that are farther away, fill a larger room with bounce flash, and use lower ISOs. More powerful flashes also tend to recycle faster, so they're ready for your second or third shot faster than flashes with lower outputs.

Flash output is measured by the Guide Number (GN), and flash manufacturers always tell you the GN. The GN is the distance that a flash can illuminate a subject. It's really difficult to compare the GNs of flashes from different manufacturers, however, because it varies depending on the position of the zoom head, the size of the sensor, the camera's ISO setting, and the manufacturer's testing procedures.

Generic flash manufacturers, in particular, have been known to exaggerate the GN. For example, the Sigma EF-610 claims to have a higher GN than just about any other flash on the market. Independent tests, however, show that it has only about half the stated output. Canon and Nikon, however, tend to under-state their GNs, and testing shows that the name brand flashes are even more powerful than the manufacturers claim. The tables at the end of this section show real-world GNs where available.

If you use a flash with a lower output, you can simply choose a higher ISO on your camera's settings. Each time you double the ISO, you double the effectiveness of your flash. Increasing the ISO also increases the noise in your picture, so you can think of more powerful flashes as reducing the noise in your images by allowing you to use lower ISOs.

For most photographers, the GN isn't nearly as important as other factors, such as cost, having a bounce and zoom head, reliability, and recycle time.

Through-the-lens (TTL) metering

The farther you are from your subject, and the darker the subject is, the more flash you need. So, your flash can't simply fire with the same strength all the time.

It's your camera's job to tell the flash how brightly to fire. To determine that, the camera puts out some light from the flash (it usually appears as a flickering) and measures the light as it bounces off the subject and back through your lens. This process is known as through-the-lens (TTL) metering. Canon and Nikon have proprietary systems that they call evaluative-TTL (E-TTL), digital-TTL (d-TTL), and intelligent-TTL (i-TTL).

TTL support is extremely important if you plan to mount the flash to your camera. If your flash doesn't support TTL metering, you'll need to adjust the flash output for every picture you take. If every photo is planned, or if you plan to use the flash off-camera, you'll probably end up manually adjusting the flash output, anyway, so it's not important. However, if you plan to take candid or spontaneous photos, you need a flash that supports TTL.

As long as a flash has TTL support, the difference between TTL, E-TTL, d-TTL, and i-TTL are relatively minor. Yes, the newest TTL technologies from Canon and Nikon can improve your flash exposure in some scenarios. If you're a wedding photographer or a photojournalist and you won't have time to review your exposure and re-shoot if you need to, these improvements might be worth the extra expense. For most of us, however, generic TTL flashes work well enough.

Bounce head

The single most important feature of an external flash is a bounce head. Bounce heads allow you to point the flash in different directions to bounce the light off the ceiling or walls. They're tremendously useful, and they allow you to add light without having that "flash" look: an overexposed foreground with a dark background.

Not all bounce heads are created equal, however. Some bounce heads only tilt up. If you hold your camera vertically, the flash would be pointed at the wall instead of the ceiling, completely changing your lighting. Therefore, the ability to rotate the flash

side-to-side is very important, but often reserved for higher-end flashes, so choose a flash with a bounce head that both tilts and rotates.

Zoom head

Zoom heads focus the flash's light beam to match the focal length of your lens. Without a zoom head, your flash would always attempt to fill the view of a wide-angle lens, even if you were zoomed in on a faraway subject. Therefore, the zoom head uses your flash output more efficiently, allowing you to reach greater distances and reducing the output required. The less output a flash uses, the faster it will recycle, and the more flashes you will get out of your batteries.

High-end flashes have zoom heads and will automatically zoom to match your lens' focal length. They have limits, however. For example, the top-end flashes from Canon and Nikon both zoom up to 200mm, but lower-end flashes might only zoom to 50mm or 105mm. If taking a picture of your friends with a 100mm lens and your flash only zooms to 50mm, light will still reach the subject, but some of the flash will illuminate the scene outside of the frame and will be wasted. Your subjects will probably still be well illuminated, but your flash batteries won't last as long and you will need to wait longer between taking pictures.

High-end flashes have automatic zoom heads. Your camera communicates your current focal length to the flash, and the flash automatically zooms to match the length, taking into account your sensor size. This is very important for candid shots where you don't have time to plan. It also means you won't forget to change the flash zoom. Lower-end flashes might have manual zoom heads, and sometimes support only two different focal lengths, such as 24mm and 50mm.

Some flashes include a diffuser that flips down in front of the flash head to distribute the light across a wider area. Without the diffuser, most zoom flashes only zoom out to 24mm. Therefore, if you were to take a picture at 18mm, only the center of the picture would be illuminated. Flipping down the diffuser spreads the light a little wider, fully covering an 18mm scene for super wide angle shots.

Zoom heads are only useful when your flash is pointed directly forward. Therefore, you won't bounce the flash and use the zoom head at the same time. To shoot a variety of different situations, however, it's important to have both a zoom head and a bounce head.

Recycle times

The recycle time is the amount of time you have to wait after taking a flash picture. If you take a picture before the flash has recharged completely, the flash might fire at less than full power, leaving your picture underexposed.

Recycle times are very important, yet there's no consistent way to compare recycle times between different flashes. In general, flashes with a higher GN have faster recycle times. Adding an external battery pack can also improve recycle times. Therefore, if you need a fast recycle time (which is extremely important for wedding and event photographers) choose a flash high a high GN and support for an external battery pack.

External battery pack support

Higher-end flashes have a jack for connecting an external battery pack. The extra batteries extend your battery life, allowing you to take more shots before changing the batteries, and they reduce recycle time, allowing you to take photos faster.

Most people don't need a battery pack for their flash. Therefore, the battery pack jack is a feature found only on higher-end flashes. Wedding and event photographers, however, should choose a flash that supports connecting an external battery pack, because those scenarios often require you to take flash shots as fast as possible, and you might miss a shot in the time it takes you to change your batteries.

Rather than buying a battery pack from your flash manufacturer, look for a generic battery pack designed for your flash. They cost a fraction of the name brand version and work just as well.

Diffusers and reflector cards

Some flashes have light modifiers built directly into them. For example, they might have a built-in diffuser that you can flip down to cover the flash head and distribute the light across a wider area. Other flashes have a small white card that bounces some of the light forward; useful for creating a catch light when using a bounce flash.

Built-in diffusers and reflector cards are convenient because they're always there. If you don't have these features, you can buy attach a third-party diffuser or reflector card to your flash; the only downside is that you have to carry it with you. For more information, refer to Chapter 3.

PC sync jacks and cords

Sync cords (often known as PC cords) are an old standard for triggering a flash. Basically, you can plug one end of a sync cord into your flash and the other end into a camera or remote trigger, and the flash will fire whenever you take a picture. If you just connect your flash to the hot shoe on top of your camera, you never have to worry about a sync cord. However, sync cords can be useful for triggering an off-camera flash.

Sync cords don't communicate much information; they really just tell the flash when to fire. On the other hand, the flash hot shoe (the bottom part of the flash that mounts to the top of your camera body) can communicate a great deal of information about the distance to the subject, ambient lighting, focal length, and desired amount of flash output. Because the flash hot shoe is so much more powerful, most photographers trigger remote flashes using the hot shoe, either by using an off-camera flash cord or by using a wireless trigger.

So, some flashes and camera bodies have a PC/sync jack that you can connect a sync cord to. If your camera or flash doesn't have this feature and you need it, you can get an inexpensive ($10) adapter that uses the hot shoe to connect to the sync cord. But, you'll probably never need it, so don't pay more for a flash just to get a PC/sync jack.

Manual controls

All flashes allow you to control their output using flash exposure compensation built into your camera. Lower-end flashes designed for the casual photographer don't have any extra buttons or controls. Therefore, if you want to adjust your flash output up or down, you need to adjust the flash exposure compensation using your camera's controls.

Higher-end flashes designed for enthusiasts and pros include controls directly on the flash. These aren't really necessary as long as your flash is attached directly to your camera. However, if you want to use your flash off-camera, those manual controls can be very useful. For example, if you're doing a portrait shoot and you move a flash behind your subject to provide rim lighting, you could use the buttons on the flash to reduce the flash output to get exactly the lighting you need. Flashes that lack manual controls typically fire at full-power when they are not connected to a camera or wireless trigger, and the full-power output would quickly wear through your batteries, would take much longer to recycle the flash, and it might be much more light than you need.

High-speed sync

As described in the "X-sync speed" section of this chapter, and the "Flash Sync Problems" section of Chapter 5, camera bodies can't use a traditional flash faster than the camera's X-sync speed, which is usually about 1/200th. If you use a faster shutter speed, the flash might not evenly illuminate the frame.

Because flash is primarily used for portrait work where high shutter speeds aren't necessary, the need to use a slower shutter speed only becomes a problem in bright daylight when you might want to also use a small f/stop number to blur the background. If that's a scenario you need to be prepared for, you should choose a flash that supports high-speed sync. For Canon and Nikon, I recommend the Yongnuo 568EX II ($200). It's the only generic flash that supports high-speed sync, so if that's a requirement, your flash purchasing decision is easy.

No generic flashes support high-speed sync for Sony or micro four-thirds cameras, so photographers on those systems will need to choose a name brand flash.

Audible ready notification

Some flashes include an audible beep to let you know when they have completely recharged. You don't really need this when you're using an on-camera flash, because you can hear the flash recharging, and you'll soon become accustomed to the sounds your flash makes. However, the audible beep can be useful when using a flash off-camera.

Focus assist light

Some flashes include active focusing capabilities, which transmit a focus assist light (usually red or infrared) that helps the camera focus on nearby subjects in dark rooms. Some camera bodies have a focus assist light built right into the body, as well.

Focus assist lights are limited in their usefulness. First, they generally only transmit a beam across the center of the image, so you need to be using the center focusing point. Second, the beam only reaches a few feet, so you need to be within about ten feet of your subject (but sometimes closer). Third, many modern cameras are quite capable of focusing in dimly lit environments without an assist light. Nonetheless, focus assist lights can be useful when taking pictures in dimly lit bars and restaurants. Typically, however, I wouldn't pay extra for the feature.

Video lights

Some low-end flashes include an always-on LED light that you can turn on for use with video. Basically, it's a small flashlight that lights up nearby subjects if you're filming. When built into flashes, these video lights are very small and tend to look terrible. I don't recommend buying a flash with a video light. Instead, buy a dedicated video light, such as the *Neewer CN-160 ($40)*. The larger surface area and brighter output will light a larger area and provide a much more flattering light.

Modeling lights

A modeling light stays on constantly, and is intended to simulate the light that the flash will produce so that you can adjust the light or your model without taking test shots. Because modeling lights are not as bright as the actual flash, you can't use them to assess the brightness or power output of the flash. Howev bright enough to see if your flash position is making an ugly shadow on your model's face.

A modeling light is a nice-to-have feature, but it's not particularly important because modeling lights are never all that accurate. Especially outside of the studio, I prefer to simply take a test shot, make adjustments, and then re-shoot.

Light modifiers

You can buy a variety of diffusers and soft boxes that fit onto your flash head to modify the light. For detailed information about their use and example pictures, refer to Chapter 3 of Stunning Digital Photography.

Flash AA battery and charger recommendations

If you use flash regularly, batteries can get really expensive, and I know you'd rather spend that money on new camera equipment. For most of us, rechargeable batteries are the right choice. Rechargeables tend to last longer and recycle flashes faster, too.

The *Sanyo Eneloop XX AA batteries* are the best rechargeables you can buy for flash. However, the *standard Sanyo Eneloop AA batteries* are the best value: they're almost as good and the price is much better, so buy three sets. Keep one set in your flash, keep another set in your camera bag so you can swap the batteries out if recycle times get too long, and keep the third set in the charger at all times.

The Eneloops give you about 30% faster flash recycle times than other batteries. If you need to buy batteries and you can't find the Eneloops (they're not commonly available in stores), buy standard Duracell batteries. Ignore higher-priced varieties like the Duracell Ultra Power or Energizer Max.

For the casual photographer, any AA charger should be fine, including the *optional charger with the Eneloop batteries*. However, most AA chargers have a drawback that can reduce your flash performance: they charge the batteries in pairs. This

can result in one of the batteries in the pair not being completely charged. I recommend the *La Crosse BC-700* ($40) because it charges each battery separately, it's small enough to travel with, and it has features to maximize and monitor your battery life.

Chapter 6: Wireless Flash Trigger Buying Guide

Flashes can be controlled wirelessly, allowing you to move your flash off-camera and light your subject from a different angle. This technique is primarily used for planned portraits.

There are three primary techniques for wirelessly triggering flashes:

- **Optical**. Slave flashes fire when they detect the bright light from another flash. This technique works reliably, but does not allow you to control remote flashes. You wouldn't want to use a flash trigger if other photographers were using flash, because your slave would fire anytime someone else took a picture. Some flashes have optical slaves built-in, but you can add an inexpensive optical slave to any flash. Optical slaves work with any model of flash, including a camera's built-in flash.
- **Infrared**. Many flashes can communicate using infrared signals. This allows you to control the output of slave flashes from the master flash and prevents other photographers from inadvertently firing your flash. However, infrared flashes require line-of-sight communications, so slave flashes have to be facing the master, and they might not go off if someone walks between the flashes.
- **Radio**. You can also buy radio flash triggers, such as those made by PocketWizard, and connect them to any flash or studio lighting equipment. Radio flash triggers can work with generic flashes, allowing you to use less expensive flashes. Because they use radio waves instead of light waves, they have a greater range and will continue to work even if someone walks between the master and the slave.

There are also two varieties of infrared and radio triggers:

- **Non-TTL "Radio Poppers"**. These triggers (starting at about $10 per flash) simply fire the flash according to the settings on the back of the flash. If you decide you need to change the light output, you need to walk to the flash and push buttons. Because you probably need to take another test shot to see if you go the lighting right, non-TTL flash triggers can make setting up a shot very time-consuming.
- **TTL/Remote Control**. More expensive triggers (starting at about $45 per flash) communicate with the camera or the transmitter, allowing you to control their light output without leaving your camera. This allows you to make adjustments much more quickly.

This chapter will discuss the features typically found on different flashes so that you can determine which features are worth the extra cost and which you simply don't need.

Video: Flash Trigger Review

24:15

sdp.io/FlashTrigger

Infrared Flash Systems

Nikon, Canon, and Sony each have their own techniques for using infrared signals to wirelessly trigger flashes. Unfortunately, with the exception of the newest Canon flash (the 600EX-RT) the wireless trigger systems all require line-of-sight between the flashes. As a result, they tend to be too unreliable for professional user. For consumer use, they tend to be too expensive, since you're required to purchase name-brand flashes.

Therefore, I don't recommend using the Nikon, Canon, or Sony infrared flash systems. Instead, I recommend using radio triggers (typically with third-party flashes) for off-camera use. This arrangement provides more reliable control at a much lower price.

Optical Slaves

Many generic flashes include optical slave capabilities built-in. An optical slave will trigger the flash whenever they see another flash. An optical slave is extremely convenient; it works with almost any camera that has an on-camera flash, so you don't usually have to worry about compatibility. You also don't need to buy separate wireless triggers.

Optical slaves have a couple of downsides:

- **Range**. Because the slave must be able to see the on-camera's light flash. Therefore, you need to use them within about 15 meters/45 feet outdoors or about 25 meters/75 feet indoors.
- **Other photographers**. Any flash will trigger an optical slave. Therefore, if another photographer takes a flash picture, your optical slave flash will fire. If you're taking posed pictures at a wedding where guests are constantly taking their own pictures, your optical slave would be constantly firing unnecessarily, wearing down the batteries and perhaps ruining the lighting on other photographer's pictures.
- **Shadows**. Optical slaves need to be able to see your camera's flash. Therefore, if they're directly behind an obstruction, they might not be able to see the flash. Know where the optical slave sensor is on your flash to ensure it is facing your main flash.
- **Sunlight**. Direct sunlight pointing into the optical slave sensor can cause the optical slave to not detect a flash.

If your flash does not have an optical slave built-in, you can buy an *optical slave trigger* for less than $10. However, I suggest avoiding the potential frustration (especially if you are planning an outdoor shoot) and buying an inexpensive radio trigger.

Radio Triggers

Most radio triggers involve a transmitter that attaches to your camera's flash hot shoe. Once attached, they communicate with your camera through the pins on the flash hot shoe and impersonate a genuine Nikon, Canon, or Sony flash. Your camera will think it has a simple flash directly attached, but the wireless system will intercept the signals and trigger the local or remote flashes.

Radio Trigger Features

The systems vary by price and features. The most important features are:

- **Local TTL**. All of these systems attach the transmitter directly to your camera's flash hot shoe, and they allow you to stack a flash directly on top of the transmitter, so you can still use an on-camera flash. Those systems that support Local TTL allow the on-camera flash to function just as it always would, automatically adjusting the exposure as needed. The least expensive systems do not support Local TTL, requiring you to manually adjust the on-camera flash output when you change the distance to your subject or camera settings.
- **Remote TTL**. The least expensive systems will simply fire the remote flashes, without telling them how brightly they should fire. Therefore, if you want to make a flash brighter or dimmer, you will need to walk over to it and adjust it using the buttons on the back of the flash. This system is often referred to as a "radio popper", and it's all you need for studio lighting systems. The more expensive systems communicate power output to the remote flashes, allowing your camera to automatically adjust their output if the lighting changes, if you change your camera's aperture or ISO, or if you want to adjust the ratio of different lights to achieve different effects. If you're using more than one flash, I highly recommend using a system with remote TTL.
- **Range**. Range is the distance at which you can fire remote flashes. The range listings are optimistic, and you'll only ever get that range when there's nothing between you and your flashes. Walls, interference from other electronics, and many other factors will change the effective range, but generally, a longer range is better.
- **Display**. The Pixel King Pro and Phottix Odin have LCD displays that allow you to view and change the output of different flashes directly from the unit, and the PocketWizard's optional AC3 add-on unit provides dials and switches. The other systems completely lack a display, requiring you to adjust the power output using your camera's menu system (for Canon cameras) or a master flash (for Nikon cameras). The advantage of the display to Canon users is that it's slightly more convenient than the camera's menus. The advantage of the display to Nikon users is that you don't need to purchase a master flash (such as an SB-700) and keep it on camera.

The following table shows several products for remotely triggering your flashes from your camera. My recommendations are highlighted. Note that the less expensive models aren't as reliable as the more expensive models:

Name	Price	Local/Remote TTL	Range	Display	AF Assist
Cowboy Studio NPT-04	$30	No/No	30m	No	No
Yongnuo RF-603	*$30*	*No/No*	*100m*	*No*	*No*
Phottix Stratos II	$95	Yes/No	150m	No	No
Yongnuo YN-622	*$85*	*Yes/Yes*	*50m*	*No*	*Yes*
Pixel King Pro	*$150*	*Yes/Yes*	*300m*	*Digital*	*No*
Phottix Odin	*$320*	*Yes/Yes*	*100m*	*Digital*	*No*
PocketWizard MiniTT1 and Flex TT5	$420	Yes/Yes	250m	Analog (with AC3)	No
Canon 600ex-rt	$840 (with flash)	Yes/Yes	250m	Yes	No

Non-TTL Radio Triggers

Three of the remote triggers do not support TTL for remote flashes: The Cowboy Studio NPT-04, the Yongnuo RF-603, and the Phottix Stratos II. Therefore, if you want to adjust the brightness of a remote flash, you have to walk over to the flash. Then, you'll need to return to your camera to take another sample shot and check the exposure. If it's still not right, you're walking back to your flash.

If you make a camera adjustment, such switching from f/8 to f/5.6, you will need to walk to every flash and drop the output by one stop to keep the light the same. If the sun goes behind a cloud, you will need to revisit every flash. It gets frustrating quickly, for both the photographer and the model. But, that can be OK for occasional amateur use.

As a professional, you'll either want an assistant who can make the adjustments while you stay at the camera, or you should purchase one of the trigger systems that does support remote TTL. The remaining four trigger systems allow you to control the output of your remote flashes without leaving your camera. This makes fine-tuning your light much faster, and allows you to make adjustments to your camera's aperture and ISO and have the flashes automatically adjust.

Note: the Phottix Stratos II system does not support remote TTL. However, if you attach a flash to the top of your camera (directly to your transmitter) TTL will still work for that one flash.

Yongnuo YN-622

I only recommend two of those four systems. For under $85 for a single remote flash, and $45 for each additional remote flash, the Yongnuo YN-622C (for Canon) or YN-622N (for Nikon) gives you full remote control over up to three groups of flashes. You also get an AF assist light on the on-camera transmitter, which helps you focus in dark environments (such as at a wedding reception). No other transmitter has that feature, so you would need to add an on-camera flash with AF assist at extra cost.

Another advantage of the YN-622 system is that every unit can function as either a transmitter or receiver. Therefore, you can buy one extra unit and use it as a backup transmitter or receiver. With the other systems, you would need to purchase a separate backup transmitter and receiver.

The drawback to the YN-622 is that they lack a way to control flash output directly from the device. For Canon cameras, you can use your camera's menu system, which isn't too inconvenient. Therefore, I strongly recommend this system to Canon users. If you opt for this system, scrap the manual and read *The Other YN622C User Guide* instead.

For Nikon cameras, you could technically use a series of button pushes to control the flash output, but it's not practical. Instead, you'll need to add a master flash on top of the YN-622N, even if you don't plan to use the on-camera flash. Nikon users might want to opt for the Pixel King Pro or Phottix Odin instead.

Depending on the flashes you plan to use, compatibility with the YN-622 could be a problem. The YN-622 impersonates the native Canon or Nikon wireless flash communications, so you'll be limited to the capabilities that the native flash system supports.

Specifically, the YN-622C requires one of the following:

- A Canon EXII series flash

- The new Canon 600EX RT
- A Yongnuo flash that supports ETTL, such as the YN-568EX II

The YN-622N simply requires a Nikon or Yongnuo flash, such as the SB-700 or YN-568EX.

Though Yongnuo doesn't officially support them, the YN-622 system also seems to work with the Phottix Mitros flashes, and many Nissin and Metz flashes. Other brands of flashes might or might not work.

Those options won't be a problem or most people. However, the Phottix and PocketWizard systems are a bit smarter, and can provide manual control over older Canon and Nikon flashes. If you're buying new flashes along with the YN-622s, simply choose Yongnuo flashes and you'll have no compatibility problems whatsoever. If you do have older Canon or Nikon flashes, sell them and buy new Yongnuo flashes—you'll probably break even.

Pixel King Pro

The Pixel King Pro provides similar capabilities to the YN-622, but adds a display and controls over flash output directly on the device. Unfortunately, the controls aren't especially easy to use; adjusting flash output is a rather clumsy process. On a Canon camera, I'd rather use the camera's menu system, making the YN-622 a better, cheaper, and lighter choice. On a Nikon camera, the display and controls save you from needing a master flash (such as an SB-910 or SB-700) attached on-camera, reducing both cost and weight.

Like the YN-622, the Pixel King Pro closely impersonates the native Canon and Nikon communications systems. Therefore, the flash compatibility is similar.

The Yongnuo ETTL flashes work with the Canon model, but not with the Nikon model.

These links show the official compatibility charts for *Canon* and *Nikon* models (you have to select the Compatible tab).

Phottix Odin

The Phottix Odin system costs much more than the YN-622: $320 for a single flash, $400 for two remote flashes, and $130 for each additional flash. However, it allows you to quickly adjust the flash output using the buttons on the back of the transmitter. It also has its own LCD display so you can view the power output of every flash group, without opening your camera's menu system (for Canon cameras) or adding a master flash (for Nikon cameras).

In my experience, using the Phottix system to adjust flash output is a clumsy, but workable process. Changing the output of a flash group requires pressing the SEL button multiple times, and then pressing the MODE, +, or – buttons repeatedly. On a Nikon camera, this is your only option for manually controlling the output of the flashes.

On Canon cameras, you can also use the Flash Control menu built into all modern Canon DSLRs. I prefer making adjustments from the camera's menu, mostly because the display on the camera is brighter and in color, and the buttons are easier to press and have a better feel. Adding the Flash Control menu to My Menu helps speed the process. Fortunately, the Phottix Odin system works perfectly with the Canon Flash Control menu, which the PocketWizard system does not.

The Phottix Odin system allows you to individually remotely control the zoom level of every flash group. No other wireless flash system allows this. It seems like a useless feature, however. Typically, I adjust the flash zoom when I physically configure the flash and light modifier, and I've never felt the need to remotely adjust the flash zoom.

For Canon flashes, the Phottix Odin system offers greater flash compatibility than any of the other systems. They advertise compatibility with all Canon cameras, and in my experience, they are remarkably compatible.

I connected my 18 year-old Canon 380EX, which was designed to be fully automatic and lacks any manual controls, and the Odin gave me complete control over the flash output and zoom. All the other wireless flash systems simply fired the flash at full power, making it useless. You probably don't have an ancient flash, but this compatibility can still be good for you, because it allows you to save money by buying extremely inexpensive used flashes. For example, my 380EX sells used for

$35-$60, but connected to a Phottix Odin, I have the same wireless control as with a $500 Canon 600EX-RT.

Naturally, the Phottix Odin is compatible with the excellent Phottix Mitros flash. Unfortunately, it is not compatible with the TTL Yongnuo flashes, such as the YN-568EX and YN-568EX II.

One potential downside to the Phottix Odin system is that the on-camera transmitter does not have a flash hot shoe for connecting an on-camera flash. This isn't a problem for portrait work, because portrait photographers typically move their flashes away from the camera. However, it will be a problem for wedding, sports, and event photographers who might want to remotely fire flashes to provide ambient lighting, while simultaneously using an on-camera flash to front light their subjects. Using the Phottix system, you would need to connect a flash and Odin receiver to a flash bracket, making your camera much clumsier.

PocketWizard

The PocketWizard system has been the industry standard for years, and perhaps that's why they feel justified in charging so much more. For most of us, the base system of the Mini TT1 and Flex TT5 offer no advantages over the YN-622, but it's priced five times more expensive.

To make adjustments to the flash output of different groups of flashes, you need to add an AC3 controller ($80, *Canon*, *Nikon*). Its three switches and dials seem primitive compared to the less expensive Phottix Odin, but in practice, they're much more efficient, and I MUCH prefer the AC3's analog controls to the button-driven Canon, Nikon, Pixel King Pro, and Phottix systems. With the AC3, I can adjust flash output three or four times faster than with the other systems.

Another factor to consider when evaluating wireless flash systems is compatibility with third-party flashes. They all work with recent flashes made by your camera manufacturer (as long as the flashes are compatible with the camera manufacturer's own wireless system). However, they vary in their support of third-party flashes.

For example, the Phottix Odin wireless control system works well with recent Canon, Nikon, and Phottix Mitros flashes. However, it doesn't work with the Yongnuo TTL flashes. It also doesn't provide control over flash output or flash zoom with older flashes, which the Phottix Odin system excels at.

Additionally, the PocketWizard system has radio frequency (RF) interference issues with several popular Canon flashes, including the Canon 580EX and 580EX II. Those flashes work, but for best results you need to wrap them in shielding included with your FlexTT5, which is inconvenient. If you're buying Canon flashes specifically for PocketWizard, these models offer the best value (especially used) and don't require shielding:

- Canon 550EX
- Canon 430EX II

Nikon flashes don't have RF interference issues, and any of these flashes work well as remotes: SB-400, SB-600, SB-700, SB-800, SB-900, and SB-910.

You can use any of these wireless systems to fire studio lights, only PocketWizard allows you to control their output from your camera. Just like you can remotely control flash output, you can control several popular types of studio lighting using your AC3. Specifically, you can use:

- The PowerST4 receiver to control Elinchrom RX monolights
- The PowerMC2 receiver to control Einstein E640 monolights
- The AC9 adapter with a FlexTT5 to control AlienBees or White Lightning monolights

You can mix-and-match different systems, so Group A could be an Einstein monolight, Group B could be an Elinchrom RX monolight, and Group C could be multiple speedlights. If you want a single system that can control both speedlights and monolights, PocketWizard is your only choice.

If you're primarily looking for a system to control the output of studio lights, you will need to compare the PocketWizard system to the systems designed by the monolight manufacturers. Specifically, Einstein, AlienBees, and White Lightning monolights can be controlled with the *CyberSync Cyber Commander* (*$180 for the transmitter*, *$90 for each AlienBees or White Lightning monolight*, or *$30 for each Einstein monolight*). Elinchrome's Skyport system provides remote power control from your camera, phone, tablet, or computer (*starting at only $34*). Both of these systems are significantly less

expensive than the PocketWizard system, but I still prefer to the AC3's simple dials and switches.

Canon

The Canon 600EX-RT system currently only works with Canon 600EX-RT flashes (though Yongnuo has a generic alternative planned), which cost $550 each, even though you might simply be using them as a hair light, or to bounce light off the ceiling at a wedding reception. However, you don't need to fuss with separate receivers for each flash. That means there's less to carry, fewer batteries to replace, and less to fail. If cost is no object, the Canon system is clearly the best. I'd avoid buying the ST-E3-RT, however, because it lacks an AF assist light and its display is horizontal, requiring you to lower the camera to waist level to view the settings. Instead, purchase an extra 600EX-RT and use it on-camera, even if you turn off the flash output.

Wireless Flash System Cost Estimates

Check the manufacturer's website, and search the Internet, to determine if a particular flash system is compatible with flashes you already have. Here's an estimate of what it would cost with different systems to remotely control three different off-camera flashes with high speed sync and TTL while separately controlling the output of each flash from your camera.

System	Components	Total Cost	Benefits
YN-622C (Canon)	4x YN-622C 3x YN-568EX II	$723	Cheapest Canon solution with full control using the camera's display
Pixel King Pro	1x Pixel King Pro 3x Pixel King X 3x YN-568EX II or YN-568EX	$882	Cheapest Nikon solution with full control. Has a display, but the controls are clumsy
YN-622N (Nikon)	4x YN-622N 3x YN-568EX 1x SB-700	$1,043	Requires you to put an SB-700, SU-800, or SB-910 on-camera to control the remote flashes, even if you don't plan to fire it
Phottix Odin	1x Phottix Odin Transmitter 3x Phottix Odin Receiver 3x Phottix Mitros	$1,560	The Odin's large display is easy to use, but makes your camera a bit clumsy
Canon	1x ST-E3-RT 3x 600EX-RT	$1,937	Canon's native solution is powerful but relatively expensive

Unmentionable and Unavailable Options

There are many other radio trigger options available. However, I would only recommend radio triggers that were available through major distributors and that had a reasonably large existing following. Smaller manufacturers that can't get themselves listed at major retailers such as Amazon, B&H, and Adorama simply don't inspire confidence. However, I will keep an eye on these options, and add them to future editions of the buying guide if they prove reputable.

2013 has been a big year for radio trigger systems, and in the last few months of the year several manufacturers have announced important updates. However, these updates are not yet available for sale as of the time of this writing (October 2013). Therefore, I can't yet give them a recommendation, but I hope to review them soon:

- **Phottix Mitros+**. Phottix is releasing flashes that have their TTL Odin receivers built-in, saving you the hassle of buying a separate receiver and attaching it to the flash. Functionally, this should be very similar to the Canon 600EX-RT flash, allowing the Phottix Odin transmitter to function like the Canon ST-E3-RT. However, Phottix will certainly be less expensive. Phottix has already promised to ship me samples when the Mitros+ is available in late October 2013.
- **Yongnuo YN-622N-TX, YN-622N-RX, YN-622C-TX, YN-622C-RX**. This upgrade to the YN-622C and YN-622N adds an LCD display to the transmitter, giving you direct control over your flash output without requiring Nikon users to attach a master flash to the camera. Canon users might still prefer to use their camera's menu system.

- **Yongnuo YN-E3-RT and YN600EX-RT**. Like the Phottix Mitros+, Yongnuo is following in Canon's footsteps by releasing flashes with the radio receiver built-in. Though pricing hasn't yet been announced, I suspect the Yongnuo system will be less expensive than both the Canon and Phottix varieties.

For detailed information about controlling flashes wirelessly, refer to Chapter 6 of Stunning Digital Photography, "Portraits."

Chapter 7: Studio Lighting Buying Guide

Flashes are every photographer's first step into controlling light. We start with on-camera flash, and then move the camera off-flash to achieve different lighting effects.

The next step is always to add multiple light sources, and this is where photographers divide. Some photographers add multiple flashes and control them using the technologies described in the previous chapter. Other photographers keep their single flash for on-camera use, and add larger monolights to create studio-quality lighting, whether in the studio or on location.

The previous chapter described technology designed to allow you to create multi-light setups with standard flashes, monolights are a much better choice for most portrait, wedding, product, and commercial photographers, whether amateur or professional. In fact, I believe that far too many photographers invest in complex multi-flash setups when they should choose less expensive, more powerful, and often just as portable studio lighting.

This chapter provides quick recommendations for beginner studio lighting. For those of you who want to understand the technology so you can make your own educated buying decisions, I'll go into detail about the most important considerations for choosing studio lighting, and give you an overview of the most popular brands of studio lights.

Video: Studio Tour **8:54** *sdp.io/TourStudio*	

Quick Recommendations

Depending on your budget, here are recommendations for systems for use either in a fixed studio or on location when you can plug them into a wall outline. Most of these are four light systems. It's common for beginner kits to have only one or two lights, and indeed, I recommend mastering the use of a single light before adding more lights. Ultimately, though, you'll want four or five lights for a decent studio setup. Feel free to choose the budget you're most comfortable with, buy just one or two of the lights and light stands, and add the rest of the system later.

Notice that I no longer need to provide separate recommendations for Canon and Nikon; all monolights will work equally well with either system. You can use adapters to connect monolights to almost any other type of cameras, too, including Sony and Minolta (and just about any camera except your camera phone).

- **$240 (2 lights, AC powered)**: *The CowboyStudio 320 Watt Photography Studio Monolight Flash Lighting Kit* includes two lights, softboxes, and both white and black backdrops. It's good enough for playing around with.
- **$440 (4 lights, AC powered)**: Add the "*CowboyStudio 320 Watt Two Monolight Photo Studio Strobe Flash Lighting Softbox Kit*" to the previous kit to have a full four-light kit on the cheap. There's
- **$850 (battery powered)**: *4xFlashpoint 180 Monolights*, *2x CowboyStudio light stand sets*. These inexpensive battery-powered monolights accept Bowens light modifiers, allowing you to use the same softboxes and beauty dishes professionals use in their studios. You don't have to buy a light modifier, though, because each monolight includes a reflector and a shoot-through umbrella. The monolights include a fairly long sync cable and optical slaves, you might consider adding radio poppers to trigger them more reliably. Different cameras connect to radio triggers differently, so it's impossible for me to make a single recommendation.
- **$1,250 (AC powered)**: *2xAlienBees B800s*, *2xAlienBees B400s*, *2xPro PBL Heavy Duty 8' Light Stand sets*, *22-inch beauty dish*, *64-inch White PLM white umbrella*, *PBL sandbag set*, radio triggers. The low-end Paul C. Buff lights provide professional-grade reliability, and you can upgrade your lights seamlessly to the higher-end recommendations that follow. The AlienBees lights retain their resale value better than almost any light, so even if you upgrade later, you won't lose much of your investment.
- **$1,700 (AC powered, remote power control)**: *2xAlienBees B800s*, *2xAlienBees B400s*, *Cyber Commander*,

4xCSR+ CyberSync Receivers, *2xPro PBL Heavy Duty 8' Light Stand sets*, *22-inch beauty dish*, *64-inch White PLM white umbrella*, *PBL sandbag set*. This setup adds the amazing Cyber Commander radio trigger, giving you control over the power output of up to 16 lights.

- **$2,000 (AC or battery powered, remote power control)**: *2xAlienBees B800s*, *2xAlienBees B400s*, *Cyber Commander*, *4xCSR+ CyberSync Receivers*, *2xPro PBL Heavy Duty 8' Light Stand sets*, *22-inch beauty dish*, *64-inch White PLM white umbrella*, *PBL sandbag set*, *1xVagabond Mini battery pack*, and extension cords. This flexible system works equally well in or out of the studio.
- **$2,800 (AC powered, remote digital power control)**: *4xEinstein e640s*, *Cyber Commander*, *4xCSXCV CyberSync Transceivers*, *2xPro PBL Heavy Duty 8' Light Stand sets*, *22-inch beauty dish*, *Large Octabox*, *shovel background reflector*, *snoot*, *PBL sandbag set*. This amazing studio set is suitable for daily professional and commercial use, and includes flexible, digital remote control over any of the lights. Upgrading to the Einstein lights from the AlienBees lights provides perfect control over white balance and action-stopping flashes.
- **$3,300 (AC or battery powered, remote digital power control)**: *4xEinstein e640s*, *Cyber Commander*, *4xCSXCV CyberSync Transceivers*, *2xPro PBL Heavy Duty 8' Light Stand sets*, *22-inch beauty dish*, *Large Octabox*, *shovel background reflector*, *snoot*, *PBL sandbag set*, *2xVagabond Mini battery pack*. This configuration adds two battery packs, assuming you'll plug two Einsteins into each pack.

Tip: Fill your sandbags with small gravel, not sand. Sand is messy.

The sections that follow provide more information about each of these components.

Take a quick look at the *Wireless Flash System Cost Estimates* section of the previous chapter (which only provides for three lights and does not include light stands or light modifiers) and you'll see that these studio lights provide much more flexibility, control, and power at a far lower cost. For example, a four-light system based on the Canon 600EX-RT flash would cost you $2,285 for the lights alone, not counting batteries, light stands, or light modifiers. Even the least expensive monolight recommendation has about 2-3 times more power than the most expensive speedlight recommendation.

Flashes vs. Monolights

Flashes (also known as speedlights or speedlites) are designed to be connected directly to the flash hot shoe on top of your camera. Most flashes have sophisticated intelligence to allow them to communicate with your camera to automatically control the amount of light, giving you perfect settings entirely automatically.

Because they're optimized to fit on top of your camera, they're lightweight and portable. Unfortunately, they also have several huge drawbacks compared to monolights:

- **Flashes cost more than monolights**. Believe it or not, most studio monolights are less expensive than most flashes.
- **Flashes have far less power than monolights**. Monolights produce 4 to 16 times more light than flashes, allowing you to use a lower ISO on your camera (reducing noise in the image) and allowing you to overpower the sun when working outdoors.
- **Flashes take far longer to recycle than monolights**. Flashes are typically powered by 4 AA batteries, whereas monolights are typically powered by electrical current from your wall. With access to all that extra power, monolights can recycle much faster. It also helps that you won't have to use monolights at full power every time, allowing you to snap multiple pictures without waiting for the flash to recharge.
- **Flashes produce rectangular light, monolights produce circular light**. Flash heads are designed to be mounted to the camera. To minimize the amount of light wasted, the shape of the flash head is the same as the shape of your camera's sensor. That works perfectly when your flash it attached to your camera, but once you move it off-camera, the rectangular shape is less-than-ideal for lighting your subjects. Monolights produce a circular light.
- **Monolights are designed for use with light modifiers**. You can attach softboxes and beauty dishes directly to your monolights, and many of them allow you to attach an umbrella directly to them. With flashes, you need separate, clumsy adapters to connect them to light modifiers.
- **Flashes have small batteries**. Monolights can be powered either by battery or wall current. Batteries for monolights tend to be much larger and more powerful than AA batteries, and when you have access to power and can plug your monolights into the wall, they'll never run out of power.

- **Monolights support more groups than flashes**. Most remote control flash systems allow you to configure only three groups of lights. That's enough to let you control the main, fill, and background light—but what about your hair light, or your kicker light? Many monolight systems are designed for more serious studios and can support independently controlling larger numbers of lights.

If you're using it on-camera, or if you need to rely on auto-exposure, buy flashes, as described in Chapters 7 and 8. If you're putting your light on a light stand, even if you're travelling with your lights, you should probably choose monolights instead.

This chapter will provide a quick recommendations for those looking to buy monolights, along with an overview of the most important monolight brands.

Flash Power vs. Monolight Power

Flashes use Guide Numbers (GNs) to measure their output, and monolights use Watt-Seconds (WS). Unfortunately, there's no easy way to convert between the two units; they're entirely different measurements. GNs estimate the reach of a flash, but that factors in the flash's zoom head. GNs assume that the flash head is zoomed all the way in, focusing the light into a narrow beam. With a monolight, the light focusing is controlled by a light modifier that you attach to it.

To make this more complicated, flash manufacturers exaggerate their GNs, and monolight manufacturers exaggerate their WS outputs. So, the numbers can't be converted or trusted.

We do know this from testing out flash outputs: monolights are more powerful than flashes. You'd expect that, given their much greater weight and size, and then fact that they're plugged into the wall rather than running off of four tiny AA batteries.

One estimate from Paul C. Buff, the genius who designed the Alien Bees, White Lightning, and Einstein monolights, is that the low-end monolights (specifically his own Alien Bees B400) have about 2-3 stops more output than the top-end flashes (specifically the Nikon SB-900). As an example, the Einstein e640 costs about 10% less than a Nikon SB-910, but the Einstein produces about 32 times more light.

Continuous vs. Strobe

I see many beginning photographers interested in buying continuous lights rather than strobes. Continuous lighting seems to have many advantages over strobes:

- They can be less expensive.
- They don't have to flash.
- You don't have to connect them to your camera.
- You can use them for video.

However, I never recommend continuous lighting to photographers. Continuous lighting is for videographers, and photographers should always buy strobes.

I personally do both video and photography, and I have one continuous lighting for video and a separate strobe system for photography. I'm a huge cheapskate, so if there were a way that I could use one system for both, believe me, I would.

But I can't. I've tried. Continuous lights have these disadvantages:

- They're not nearly as powerful as strobes. Depending on the conditions, you'll often be forced to use high ISOs, such as ISO 3200. This will introduce a great deal of noise in your pictures. You also won't be able to overpower ambient light, even indoors, making it difficult to get deep shadows and dark backgrounds.
- You don't have many options for light modifiers. First, they generally don't physically connect to beauty dishes and softboxes. Even if they did, you'd find the light modifier blocked the light output even further.
- They waste a great deal of power. Continuous lighting uses electricity continuously, even though you only need it for that split second you're taking a picture.
- They're hot. Even the new cool LED lights give off quite a bit of heat.

Fortunately, you can buy strobe systems that are extremely inexpensive.

Most photographers shouldn't use continuous lighting if you plan to use light modifiers such as softboxes. Continuous lighting is better for video, and it isn't bright enough to get great image quality for portraits. I do enjoy using continuous lighting for controlled, short-range portraits, such as headshots. For an example of how I used under-cabinet LED continuous lights to make a custom ring light, watch the following video.

Video: DIY Ring Light **3:50** *sdp.io/ring*	

Monolights vs. Pack-and-Head Systems

Monolights, also known as monoblocks, monoblocs, compacts, or self-contains, plug directly into the wall, and provide individual controls on the back of each light.

Pack-and-head systems, also known as flash packs, have a single power source that plugs into the wall. All the lights plug into the power pack, and you control all of the lights from the power pack.

Most lighting companies offer products that use both technologies. For example, most of Paul C. Buff's products are monolights, but they also offer the Zeus pack-and-head system. Most of Profoto's products are pack-and-head, but they also offer the D1 Air monolights.

In general, monolights offer these advantages:

- **Control over power output at low costs**. Even budget monolights allow you to control the exact power output of each individual light. Only higher-end monolights offer that much control.
- **Better cable organization**. With a pack-and-head system, all heads have to plug into a pack, and then the pack plugs into the wall. This means that you have more cables on your floor. If you're using a single pack, you have to route the cords for all the heads to that single pack, meaning you'll be running cords across your studio floor. With monolights, you simply plug them into the nearest outlet. This also means that you can move your lights as far apart as you need, which is useful when lighting large rooms, such as at a wedding reception.
- **Independence**. If one monolight fails, it won't impact your other monolights. If a pack fails, you won't be able to use any of your heads.

On the other hand, pack-and-head systems offer these advantages:

- **Lighter heads**. Monolights have all the electronics in the head, whereas lights designed for pack-and-head systems have most of the heavy electronics on the head, which is on the floor. With lighter heads, you can use lighter booms to support the heads. For ring flashes, which you often need to handhold, the lower weight can greatly improve the hand-holdability. For example, the ABR800 ring flash monolight is 2.5 lbs., whereas the Zeus ring flash head (which is almost identical) is only 1.5 lbs.
- **Higher outputs**. While a typical monolight has about 600 Ws of output (compared to 50-75 Ws for a typical flash),

typical packs have outputs of 1,200-4,800 Ws (and much higher). And, you can channel all that power through a single head, if you want to fill a room or permanently blind a model.

- **Lower head cost**. Because heads for pack-and-head systems don't need the electronics, individual heads can be substantially less expensive. Again comparing ring flashes, the ABR800 monolight is $400 whereas the comparable Zeus ring flash head is only $300. In practice, monolights tend to cost less overall once you factor in the pack, however.

I recommend monolights to photographers with a lighting budget under $5,000—and that's most of us, including professional portrait photographers. While there are pack-and-head systems for all budgets, the lower-end systems have very limiting and frustrating controls.

Commercial photography studios with budgets over $5,000 should consider pack-and-head systems, such as those offered by Profoto. These high-end systems offer bullet-proof reliability, power outputs that can permanently damage your retinas, and an incredibly number of different heads for different lighting requirements.

Brand Overviews

Video: Studio Lighting Comparison

31:36

sdp.io/studiolights

Modern flashes and lenses have complex, proprietary communications with the cameras. If a new company is going to make a flash or lens, they have to spend millions reverse-engineering these communications and testing their products with every different camera they hope to be compatible.

Monolights, however, have traditionally used a much simpler communication mechanism: the PC sync cord. It's just a cord that carries a simple electrical signal that tells the lights when to fire. This simple communication standard has allowed dozens, perhaps hundreds, of different companies to build monolights.

I won't be describing them all in this book. Instead, I've chosen the three most popular lighting brands: Elinchrom, Paul C. Buff, and Profoto. I'll give you quick recommendations for beginning studio setups, and then provide an overview of the products offered by each of the three brands.

Just as choosing Canon, Nikon, or Sony is a big decision because you'll be stuck with that company's accessories, choosing the brand of your lighting locks you into that system's wireless remote controls and light modifiers. If you need to add a light, you'll certainly want to use one from the same system. Therefore, you should first choose a brand that you want to invest in, and then select lights and light modifiers from that brand's offerings.

In other words, you should evaluate the brand's entire offerings. Even if you're just looking for a single monolight for your home studio, if you plan to add more lights later, and you think you might want more power, you should evaluate your future costs and upgrade options within that brand.

The following table samples the different makes and models for each brand to give you a sense for what a 4-light studio setup with wireless control over the light output will cost you.

Make	Model	Output	4 lights	4 wireless lights	Replacement bulb cost	Computer controlled?
Elinchrom	D-Lite	200 Ws	$1,360	$1,480	$58	X

Paul C. Buff	*Alien Bees*	*320 Ws*	*$1,120*	*$1,660*	*$35*	
Paul C. Buff	*Einstein*	*640 Ws*	*$2,000*	*$2,340*	*$35*	
Elinchrom	BRX	500 Ws	$2,700	$2,820	$110	X
Elinchrom	RX	600 Ws	$4,000	$4,120	$97	X
Profoto	*Air*	*500 Ws*	*$4,800*	*$5,100*	*$156*	*X*

As you can see from the highlights, I'm recommending the Paul C. Buff Alien Bees system for light studio work, the Einstein system for more serious studio work, and the Profoto system for heavy-duty commercial studios. Each system has its own merits, however.

Be sure to factor in maintenance costs. To help you estimate this, I've included the cost of a replacement bulb for each of the systems. Repair costs tend to be proportionate, with Paul C. Buff equipment being the least expensive to repair.

The sections that follow provide a more detailed overview of each lighting brand.

Paul C. Buff (Alien Bees)

The Paul C. Buff brand manufactures three lines of monolights, and a less popular power pack system. All the Paul C. Buff lights use the common Balcar mount for light modifiers. The Balcar mount is popular primarily because of the popularity of the Alien Bees lights.

You can use the CyberSync system to control any of the Paul C. Buff lights, which is one of the greatest benefits. PocketWizard also offers adapters to provide remote control over the Alien Bees, White Lightning, and Einstein lights.

The Alien Bees monolights are my recommendation for beginner and intermediate photographers thanks to their low cost, performance, reliability, and availability of light modifiers and remote controls. The Einstein monolight is my recommendation for advanced photographers.

Make	Model	New	Used	Wireless	Output (Ws)	Model Tracking	Beep Ready	Model Ready
Alien Bees	*B400*	*$225*	*$190*	*$90*		*X*		*X*
	B800	*$280*	*$215*	*$90*		*X*		*X*
	B1600	*$360*	*$320*	*$90*		*X*		*X*
	ABR800	*$300*	*$250*	*$90*		*X*		*X*
White Lightning	X800	$390	$250	$90		X		X
	X1600	$440	$300	$90		X		X
	X3200	$550	$350	$90		X		X
	e640	*$500*	*$430*	*$30*		*X*	*X*	*X*

Einstein								

Buff only sells their lights through the Paul C. Buff websites, directly to consumers, so you can't buy them at Amazon, Adorama, or B&H. While a nuisance, this is also the secret to their success, as it allows them to sell their lights at lower costs. Outside the US, the lights might be substantially more expensive.

Wireless Control

You can control the output of all modern Paul C. Buff monolights using the CyberSync system. You'll need a Cyber Commander transmitter to your camera and one receiver attached to each light.

The on-camera Cyber Commander transmitter ($180) is far more sophisticated than the remote control systems offered by other brands:

- It has a large, full-color display.
- You can control up to 16 lights independently (or combine them into groups).
- You can increase or decrease the output of all lights at once, allowing you to maintain the same exposure when you change your camera's ISO or aperture.
- You can control all lights simultaneously, allowing you to keep lighting consistent while adjusting your ISO or aperture.
- It has an extremely useful flash meter built-in to calibrate your light output. When you meter a light, the Cyber Commander will show you the actual light output on your subject relative to other lights, factoring the distance and impact of any light modifiers. With this, you can instantly balance your main and fill light for instant even lighting.
- It shows you the maximum and minimum output of different lights, so you can mix-and-match different Paul C. Buff lights.
- With a sync cord, you can fire other brands of flashes and monolights—though you can't remotely control their output.
- The Cyber Commander rotates up and down, allowing you to see it when your camera is at eye-level or at waist-level.

The capabilities combine to allow you to do some amazing things in the studio. It really will drastically reduce the time you spend setting up your lighting and solving lighting problems, and that will lead to you getting more, and better, photos.

Unfortunately, it also has significant disadvantages compared to other brands:

- The monolights don't have built-in receivers, so you have to buy a separate receiver for each light. These are $90 for each Alien Bees or White Lighting monolight, and $30 for each Einstein monolight.
- The setup is both complex and non-intuitive. You definitely have to read the manual, and getting your lights setup the first time will take you at least a couple of hours.
- The screen can be hard to read in full daylight—a problem you won't run into on systems that don't have LCD displays.

Alien Bees

These budget-oriented monolights are my recommendation for beginner and intermediate photographers. They're powerful, durable, light weight, and inexpensive. They sell used for about 85% of their new value, protecting your investment.

You can buy the Alien Bees in different, and crazy, colors. You can also just get them in standard black. I find it useful to have them in different colors, however, because it makes it easy to direct assistants to the "yellow light" or the "green light".

Buff offers heads with three different outputs, all with 6 f/stop power variability:

- **B400 ($225 new, $190 used)**. Power output from 5 Ws to 160 Ws. 2.5 lbs.
- **B800 ($280 new, $215 used)**. Power output from 10 Ws to 320 Ws. 2.9 lbs.
- **B1600 ($360 new, $320 used)**. Power output from 20 Ws to 640 Ws. 3.7 lbs.

A B800 at half power performs exactly like a B400 at full power, with identical flash duration and recycle times. A B1600 at half power performs exactly like a B800 at half power.

Generally, the higher-end lights are better than the lower-end lights, just because you have the option of using more power when you might need it. The B400 is an excellent choice for a hair light, because its light weight makes it easy to put on a boom. The power of the B1600 is really only needed if you're using a very large light modifier (such as the 86-inch PLM umbrella), if you need to use it as a bounce flash to light a very large room, or if you need to use it outdoors to overpower the sun.

White Lightning

A step-up from the Alien Bees monolights, the White Lightning lights are a bit more expensive for the same level of output. They offer a sturdier build and manual control over the modeling light, neither of which is a particularly important feature. While they're advertised as indestructible (and indeed they are extremely durable), they're also quite a bit heavier than the Alien Bees lights, making them more difficult to carry and to put on booms, and the Alien Bees lights seem sufficiently durable.

Buff offers three White Lightning models. I don't list used prices because they are relatively difficult to find used:

- **X800 ($390)**. Power output from 10 Ws to 330 Ws, making it equivalent to a B800 (but much heavier at 4.1 lbs., and more expensive). The B800 is a better value.
- **X1600 ($440)**. Power output from 5 Ws to 660 Ws. The maximum power output is similar to the B1600, but you can also push a button on the back of the unit to cut the power by 75%, allowing you to instantly decrease the total output. That can be quite useful when using light modifiers very close to your subject for soft lighting. However, the

Einstein e640 is a better value than this unit, especially when you consider that they cost the same once you add the remote control unit. 4.9 lbs.

- **X3200 ($550)**. No Paul C. Buff light offers more power output than this light, which provides 10 Ws to 1320 Ws, allowing you to easily fill the largest of rooms or overpower the sun with even a very large light modifier. Weighing in at 7.1 lbs., you'll need a sturdy light stand for it, and you probably won't enjoy carrying it on location.

Einstein

The top-end monolights from Paul C. Buff, the Einstein e640 is the only member of the lineup, and it's my recommendation for most advanced studio photographers. It offers both a shorter flash duration and better white balance than the White Lightning and Alien Bees lights. It also offers a nice digital display on the back of the unit.

The e640 offers power output from 2.5 Ws to 640 Ws, matching the maximum output of the B1600 and X1600, but offering a useful lower output, as well. It weighs 4.4 lbs.

The $500 price tag is softened by the fact that remote control transceivers are less expensive. If you use the CyberSync system, adding remote control to an Einstein only costs you can extra $30. Adding remote control to an AlienBees or White Lightning costs you an extra $90. Therefore, an Einstein with remote control costs you $530, and a White Lightning X1600 ($440) with remote control also costs you $530. However, the Einstein is a much more capable monolight, making it a much better value with remote control.

The color LCD display on the back on the Einstein looks cool, and does provide you with a great deal of information and flexibility. However, in practice, I only ever push the big up and down buttons, and I actually prefer using the analog sliders on the back of the Alien Bees and White Lightning units. The LCD screen is hard to read in full sunlight, too.

Vagabond Mini

Though it's not a light, the *Vagabond Mini ($240)* can be the most important tool you have for location lighting. Attach it to your light pole, plug your monolight into it, and you can use your studio monolights anywhere. It will power almost any monolight, including Paul C. Buff, Elinchrom, and Profoto lights—the brand doesn't matter, because the Vagabond simply provides power in a portable package (though it provides less power than your wall outlet, so your lights will take longer to recycle). In fact, I often see photographers with very expensive Profoto monolights who strap the Vagabond Mini to their light stands rather than buying one of the $1,800 Profoto BatPac battery packs.

There's good for about 400 to 500 flashes with a 640 Ws light at full power. With the aid of extension cords, you can connect up to four monolights to a single Vagabond Mini, though that will also increase your recycle time (which will already be much longer than normal).

The Vagabond Mini is only 3.5 pounds, so you can easily throw it into your travel bag and use it to charge your laptop, phone, or tablet. It even has a USB charger port built into it. It recharges in about 3 hours.

Zeus

The Paul C. Buff Zeus system consists of two power packs and three lights. The power packs put out 1250 ($600) or 2500 ($800) Watt seconds of power to either one or two lights. You don't get completely independent control over the two lights, making it less flexible than the monolight options.

The Zeus lights are:

- **Standard ($300)**. This is the head you'd use for most tasks. If you have only one of these connected to the 2500 Watt second power pack, it will put out a full 2500 Watt seconds of light.
- **Bi-Tube ($400)**. This head has two power cords, so you can plug it into two separate power packs, doubling the potential output to a total of 5000 Ws of power when connected to two 2500 Ws packs.
- **Ringmaster ($300)**. This is a ring flash, which allows you to point your lens through the middle of the light source, providing almost shadowless lighting.

The Zeus system is designed for photographers who prefer a pack-and-head system, but I recommend most photographers use monolight systems instead.

Balcar Mount

Used by all Paul C. Bluff lights, the Balcar mount is neither the easiest to use nor the most durable, but it's a reasonable compromise. Four brackets grip the circular ring of your light modifier. You'll need to move a lever or squeeze a pair of levers on your light in order to slide the speedring over the brackets, and then springs push the brackets back out and hold the light modifier in place.

It works well, but it requires you to have one hand on the light and one on the modifier. This can be a clumsy process with

heavier modifiers, and it's definitely more graceful with two people.

Alien Bees has become popular enough that just about any type of light modifier is available for the Balcar mount, both from Paul C. Buff and from less expensive third parties.

Elinchrom

Elinchrom offers a wide variety of both monolights and pack-and-head systems. Elinchrom uses the extremely popular Bowens S-Type mount of lighting modifiers, meaning you'll always be able to find any type of light modifier at the price point you need.

D-Lite	*RX ONE*	*$252*		*Free*	*10-100*
	RX 200ws	*$378*		*Free*	*20-200*
	RX 400ws	*$439*		*Free*	*40-400*
BRX	*Style 250*	*$525*		*Free*	*25-250*
	Style 500	*$675*		*Free*	*50-500*
BXRi	Style 250	$640		Free	25-250
	Style 500	$750		Free	50-500
RX	*Digital Style 300RX*	*$885*		*$139*	*9-300*
	Digital Style 600RX	*$1,000*		*$139*	*18-600*
	Digital Style 1200RX	*$1,400*		*$139*	*37-1200*

All the Elinchrom monolights that I'm describing here except for the RX models have wireless capabilities built-in, so keep that in mind when comparing their pricing to competitors that don't built-in wireless. For example, adding wireless capabilities to Alien Bees lights costs $90 per unit, or $30 per unit for the Einstein e640 light. That's included in the price of the Elinchrom lights.

Like the Paul C. Buff lights, Elinchrom lights all have model light tracking, which automatically adjusts the modeling light according to the monolight output, and they'll use the modeling light to indicate when the flash has completely recycled. Unlike the Alien Bees and White Lightning lights, the Elinchrom lights also offer an audible beep when the monolight has recycled.

Skyport RX Wireless Control

Elinchrom offers a fantastic variety of both wired and wireless remote systems, and you can use the PocketWizard PowerST4 receiver ($130) to control the Elinchrom RX monolights, if you've already invested in PocketWizards. If you choose Elinchrom, my recommendation is to invest in their Skyport wireless system. Many of their monolights have Skyport receivers built-in.

You will need to buy a transmitter (shown here) and attach it to your camera's flash hot shoe. You can use the transmitter to adjust the output of the lights in four different groups. It's simple and works wonderfully, despite the primitive interface. Be sure to buy the EL-Skyport Transmitter SPEED model ($120), and not the Eco model, because only the SPEED model provides control over light output.

You can use a second transmitter to allow an assistant to make adjustments to the lights off-camera while still triggering the lights using the on-camera transmitter.

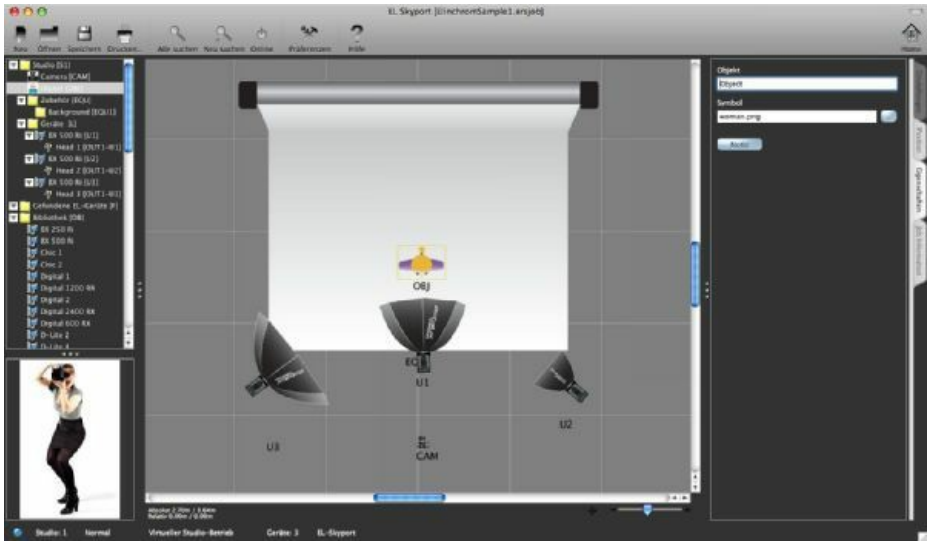
In comparison to the Paul C. Buff Cyber Commander ($180), with its control of up to 16 lights, and a full color LCD display, the EL-Skyport seems extremely primitive. However, all I ever really need is to adjust output up or down, and the EL-Skyport does that perfectly well. Four groups of lights is sufficient for most studios, too.

If you use the top-end RX monolights ($900-1400), you also have the option of using the PocketWizard system with one PowerST4 adapter per monolight ($130). I prefer the straightforward control of the PocketWizard AC3, but it's limited to three zones.

You can also control you lights from a computer running Windows or Mac OS. That sounds very cool, but I consider it to be more trouble than it's worth.

Setting up the Skyport system can be difficult. You might need to update the firmware on each of your lights. The documentation is poor and confusing.

However, once you get it running, the software provides full configuration over your lights from a computer running Windows or Mac OS. As shown in this screenshot, you can create diagrams that show the layout of your lights, helping you recreate a specific lighting setup.



Like the transmitter, the software supports up to 4 different groups of lights, which is sufficient for most studios.

Skyport RX Wi-Fi Control

Elinchrom also offers an app that allows you *to control the lights from an iPhone, iPod, or iPad*. However, none of the monolights have the required Wi-Fi support built in, so you need to add the SkyPort Wi-Fi adapter, shown here, for $200 per light. You might also need the Skyport USB RX Speed adapter ($30) to update the firmware on your lights to support the SkyPort Wi-Fi adapter.

This seems terribly cool, but I don't recommend bothering with it. It's unreliable, clumsy, and because of the cost of the adapters, very expensive. Setup is hard, and the app won't always find all your lights. It's also difficult to tell which light is which. In short, don't bother.

The sections that follow describe Elinchrom's monolights, which they refer to as Compacts.

D-Lite

The base-level Elinchrom monolights, D-Lites are offered at several different power ratings:

- **100 Ws RX One ($225 new)**. Power output from 10 Ws to 100 Ws. Replacement bulbs are $58. 2 lbs.
- **200 Ws RX 2 ($340 new)**. Power output from 20 Ws to 200 Ws. Replacement bulbs are $58. 2.9 lbs.
- **400 Ws RX 4 ($395 new)**. Power output from 40 Ws to 400 Ws. Replacement bulbs are $58. 3.3 lbs.

Elinchrom also offers IT models, but I recommend choosing the RX models because they offer compatibility with Elinchrom's amazing RX wireless system, and the RX models cost only $25 more than the IT models.

BRX

The BRX monolights are heavier duty than the D-Lite units, and therefore designed for all-day use in portrait and product photography studios. Functionally, they are very similar to the D-List models.

You should only spend the extra money on the BRX models if you plan to use them constantly and you're afraid you might wear out the D-Lites.

- **Style 250 ($525 new)**. Power output from 25 Ws to 250 Ws. 4 lbs. Replacement bulbs are $110. Minimum flash duration of about 1/2000th.
- **Style 500 ($675 new)**. Power output from 50 Ws to 500 Ws. 5.5 lbs. Minimum flash duration of about 1/500th. Replacement bulbs are $110.

BXRi

The BXRi monolights are the predecessor to the BRX lights, and I list them here only for completeness and to help reduce confusion if you're browsing Elinchrom's offerings. You might find good bargains on used models, but I don't recommend buying these new, because the BRX monolights are a better value.

- **Style 250 ($640 new)**. Power output from 16 Ws to 250 Ws. 4.1 lbs. Replacement bulbs are $90.
- **Style 500 ($750 new)**. Power output from 31 Ws to 500 Ws. 4.5 lbs. Replacement bulbs are $90.

RX

The higher-end RX models are digital, allowing you to precisely specify the output and control it in 1/10th increments, much like the Paul C. Buff Einstein e640. Unlike the Einstein unit, the RX monolights can be digitally controlled from your computer, which is only convenient if you already use a computer as part of your studio workflow.

Elinchrom offers three RX models:

- **Digital Style 300RX ($885 new)**. Power output from 9 Ws to 300 Ws. 5.1 lbs. Minimum flash duration of 1/2850th. Replacement bulbs are $97.
- **Digital Style 600RX ($1,000 new)**. Power output from 18 Ws to 600 Ws. 5.7 lbs. Minimum flash duration of 1/2050th. Replacement bulbs are $97.
- **Digital Style 1200RX ($1,400 new)**. Power output from 37 Ws to 1200 Ws. 7.5 lbs. Minimum flash duration of 1/1450th. Replacement bulbs are $155.

Before buying the RX system, compare them to the Paul C. Buff Einstein e640. The e640 is very similar in output and features to the 600RX model, but offers reduced output down to 2.5 Ws and costs about half the price. The Einstein unit cannot be controlled from a computer, but the Cyber Commander controls will be sufficient for most studio needs.

Bowens S-Type Mount

Elinchrom uses the popular Bowens S-Type mount. By far the most common mount, the Bowens mount gives you the most options. Any light modifier you can imagine is available for the Bowens mount, at any price range, from high-end professional gear to cheap third-party knockoffs.

The Bowens mount doesn't require you to have a hand on your light when installing a light modifier; simply line up the three pins, push them in, and then give it a slight twist. It locks into place. When you remove it, you have to push a button on the light to release the modifier.

Besides Elinchrom, many other lighting manufacturers have adopted the Bowens S-Type mount. Therefore, if you decide to switch to another system later, you might be able to continue to use your existing light modifiers.

Profoto

Profoto makes professional lighting equipment, and it's priced that way. They have a long history with studio photographers, and as a result, many commercial and fashion studios use Profoto equipment.

Profoto lights use Profoto's own speedring for attaching light modifiers such as soft boxes. However, their system is popular, and there are more than enough name-brand and third-party light modifiers available for the Profoto system.

If you have large, fixed studio, multiple assistants, a constant stream of commercial work, medium format digital cameras, and $10,000+ budget for lighting, Profoto's system is unparalleled. With practice, it will streamline your workflow like no other system and have you shipping a constant stream of images to your art directors.

However, the system isn't the best use of budget for amateur and portrait photographers. Instead, I recommend starting with the Paul C. Buff Alien Bees or Einstein lights, which offer most of the capabilities of the Profoto system at about one-third the cost.

The sections that follow describe the key components of the Profoto system.

Air System

The Profoto Air Remote ($300) attaches to your camera's flash hot shoe can remotely trigger and control the output of up to six groups of lights. Though the unit is overpriced compared to the competition, it's reliable and simple to use. If you are invested in the Profoto system, it's a necessary accessory.

Profoto Studio Air and Capture One Plugin

Profoto also offers free software for Windows or Mac OS that allows you to control your lights from a computer. Unfortunately, this "free" software requires the purchase of a $500 USB dongle. Remember, the Elinchrom's USB adapter costs only $30.

For most, the Profoto Air Remote is easier to use. However, the computer software provides control over more groups of lights.

If you use the Capture One software, Profoto offers a plugin for controlling their lights. Capture One is most often used with medium format digital cameras, such as those made by Mamiya and Hasselblad. Capture One allows you to remotely control and trigger your camera, and when you add the Profoto plugin, your camera settings can be linked to the light output. If you already use Capture One and Profoto equipment, the plugin is a great addition to your workflow. However, most photographers won't need it.

Air Monolights

Profoto offers five monolights, three of which support their wireless Air system:

- **D1 Air 250 ($1,100)**. Power output from 3.9 Ws to 250 Ws. Minimum flash duration of 1/1400th. Replacement bulbs are $156. 4.9 lbs.
- **D1 Air 500 ($1,200)**. Power output from 7.8 Ws to 500 Ws. Minimum flash duration of 1/2600th. Replacement

bulbs are $156. 5.4 lbs.

- **D1 Air 1000 ($1,750)**. Power output from 15.6 Ws to 1,000 Ws. Minimum flash duration of 1/1800th. Replacement bulbs are $156. 5.4 lbs.

All the Profoto equipment is designed to be used in professional environments, and is known to be reliable and sturdy.

Profoto Off-Camera Flash

Profoto's B1 500 AirTTL is a battery-powered 500Ws monolight that supports TTL, allowing your camera's autoexposure system to work correctly. Or, if you look at it a different way, it's a monster flash that's designed to be mounted on a light stand or tripod and can support a beauty dish, softbox, or other light modifier.

It can work as a standard cordless monolight, syncing in all the standard ways. However, its power is the ability to communicate exposure to your camera's TTL system, allowing you to immediately adapt to changing lighting conditions. In order to use TTL, you'll need to attach the Air Remote TTL-C (for Canon cameras) or the TTL-N (for Nikon cameras, when it's finally released) to your camera's flash hot shoe.

The B1 is quite possibly the world's greatest speedlight, but it's not for most photographers. Each head costs about $2,000, and the transmitter will run you another $400.

However, there's really no competition in this segment. If you need real monolight output and light modifiers, and you need to setup in seconds (without taking the time to manually tweak the output from manual lights), the B1 is your best and only choice.

Profoto Pack-and-Head Kits

Though I typically recommend monolights over pack-and-head kits to the up-and-coming photography, most of Profoto's lights are part of their pack-and-head systems. The sections that follow give a brief overview of the different systems.

You should note that Profoto calls their packs "generators." In the US, the term "generator" is typically used to describe an engine that turns gasoline into electricity. Profoto's generators, just like every other brand's pack systems, are mostly just capacitors that store electricity and then send it to the heads to be converted into light.

Profoto offers a flexible assortment of heads, including a ring flash ($1,700) and many specialty heads. While each system has heads designed specifically for that system, you can use lower-end heads on higher-end generators/packs. For example, you can use the Acute heads you're your D4 generator, but you can't use the ProHead plus (designed for the D4) with the Acute system; it would overpower it.

Profoto Acute System

The entry-level pack-and-head system offers a few options for packs:

- **Acute 2 1200 and 1200R ($2,100)**. These heads provide a total of 1200 Ws of output (split between up to three light heads). That's more than enough power for most indoor environments. The 'R' model includes a built-in PocketWizard receiver, but you can trigger it with any wireless receiver.
- **Acute 2 2400 and 2400R ($2,500)**. These simply provide twice the output of the 1200 models. 2400 Ws is enough to overpower the sun when working outdoors.
- **Acute B2 600 AirS and AirS/R ($2,640).** These models are battery-powered, allowing you to take them on location (but with half the output of the 1200 model). They support only one head at a time, but with 600 Ws to the head, you should be able to overpower the sun as long as the light isn't too far from your model.

The most basic kit, including an Acute 2 1200 with two heads, will cost you about *$3,700*. The higher-powered kit (with the 2400) with two heads will cost you *$4,550*.

Many photographers will own both a 1200 or 2400 head and battery-powered B2. They'll use the traditional head in-studio, and bring the B2 to outdoor shoots when power isn't available. The B2 is a good backup head, too, if something fails in your main head.

Compared with the higher-end systems, the Acute system has fairly inflexible power control. Each head has one 'A' head and two 'B' heads, and you control their output using a complex system of three switches that control the total output and how it's distributed between the A and B heads. Here's the user manual for it.

This complex system isn't unusual for pack-and-head systems. I worked with a similar system for years, and it got the job done, but it's terribly confusing, and quite limiting. You can't simply adjust the power output of a single light up or down a few stops, and fine-tuning light output usually means physically moving the head closer or farther from the subject, or adding light modifiers to block some of the light. You'll eventually get used to it, but it'll always be frustrating.

Profoto D4 System

Profoto's mid-level system offers increasing power, flexibility, and cost:

- D4 Air 1200Ws ($7,350)
- D4 Air 2400Ws ($8,400)
- D4 Air 4800Ws ($11,123)

There are several good reasons to upgrade to the D4 system from the Acute system:

- Greater output for large studio spaces or for shooting in full sunlight and longer distances.
- Individual control over the output of each head. You have monolight-like flexibility.
- Full remote control using the Profoto Air system.
- Higher frames per second.
- Increased color stability.

None of the D4 heads offer battery power.

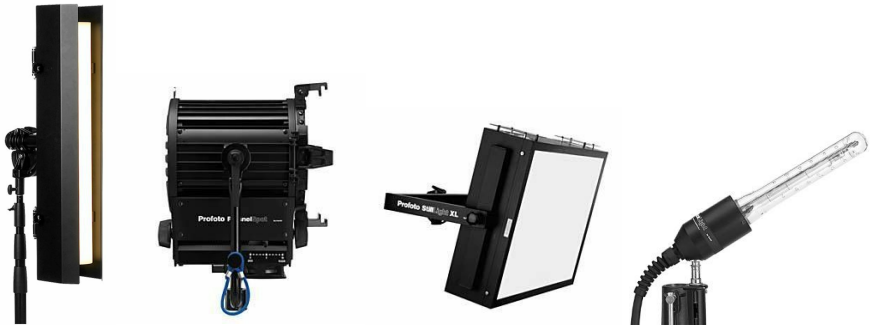
Profoto Pro System

Profoto's high-end system is the ultimate in pack-and-head lighting. You can choose from four heads:

- **Pro-8a 1200 ($11,300)**. Shoots up to 12 frames per second with a 9-stop power range. Provides individual control over two lights.
- **Pro-8a 2400 ($13,000)**. Shoots up to 12 frames per second with a 10-stop power range. Provides individual control over two lights.
- **Pro-B3 1200 AirS ($5,300)**. Offers an 8-stop power range and up to 1,200 Ws of output. Up to 300 flashes at maximum power.
- **Pro-B4 1000 Air ($7,900)**. Offers an 11-stop power range and up to 1,000 Ws of output. Up to 220 flashes at maximum power.

Each pack supports only two heads, so you'll need twice as many packs as you would if you were using the D4 system, but each head can receive up to half the pack's total output. All the heads can be controlled by the Profoto Air system.

Profoto Specialized Monolights



Profoto offers a *wide variety of specialized heads* for their pack-and-head systems, including narrow striplights, spotlights, and large light sources. This wide variety of heads is part of what makes Profoto the choice for professionals. Most photographers will never need a tiny stick light ($2,400) that they can wedge into a small place to light something from the inside out; but when you need it, you need it, and Profoto has the tool for you.

Profoto Mount

Profoto's mounts are generally considered the most solid. They'll hold onto even the heaviest light modifiers for years without showing any signs of age. The mount itself is quite simple—it's simply a cylinder, and you slide your light modifier over it (and, depending on the modifier, you might need to tighten it down).

The mount also has an important functional advantage: you can slide the light modifier closer to or farther from the head, while still keeping it secure against the light. It works much like a flashlight with a zoom head. This allows you to zoom many light modifiers, changing the quality of the light by changing the position of the light head inside the light modifier. In the previous picture of the Profoto monolight, you can see a series of numbers on the side of the light, indicating different positions you can slide the light modifier to change the zoom effect.

Unfortunately, it's not as popular as the Balcar or Bowens mounts used by Paul C. Buff and Elinchrom lights. Therefore, the mount type will limit your options for third-party light modifiers. However, if you have the budget for Profoto lights, you probably also have the budget for Profoto modifiers.

Chapter 8: Portrait Studio Equipment Buying Guide

Studio lights, by themselves, are almost useless. To get beautiful light, you need light modifiers, such as umbrellas, softboxes, and beauty dishes. This chapter explains the difference between these light modifiers and discusses other gear you might need to get great photos in your studio.

Light Modifiers

Without a light modifier, strobes produce a very harsh, uncontrolled light that spills throughout the room. You will almost always attach a light modifier to your strobes. They come in several different varieties:

Strobe reflectors

Typically included with a strobe, the reflector is a dish that simply bounces the light straight forward. Some accessories, such as grids, attach to reflectors.

Shoot-through umbrellas

Cheap and portable, umbrellas are the first light modifier that you should master. Attach a shoot-through umbrella to your light stand and point the light directly into it. The umbrella softens and diffuses the light, as well as casting it around the room.

Bounce umbrellas

Attach these umbrellas to your light stand, point the light into it, and then point the light directly away from the area you want to

highlight. Bounce umbrellas increase the size of the light source, but generally do not diffuse it. Huge focusing bounce umbrellas, known as parabolics, are popular in professional fashion studios but cost thousands of dollars.

Softboxes

Soft boxes do a much better job of diffusing and softening light than umbrellas. The bigger the soft box, the softer the light will be. It's much more work to collapse a soft box than an umbrella, so soft boxes usually stay in the studio. Soft boxes are usually square, but you can also get octagonal softboxes (known as octoboxes) to create a differently shaped catch light.

Octoboxes

Octoboxes are simply eight-sided softboxes. They work exactly the same, but provide a round catchlight rather than a square catchlight.

Strip lights

Strip lights are tall, narrow soft boxes. They're useful for evenly lighting a subject's entire body. They're also nice for creating

a straight reflection in a polished surface.

Beauty dishes

Large reflectors with a diffuser in the center. Beauty dishes have become the preferred main light for most types of portrait photography because they create a very even light with soft edges and a round catch light. Beauty dishes are easier to work with in the studio than softboxes, but they're not collapsible. You can put a diffuser (known as a sock) over a beauty dish to soften the light, or add a grid to limit the amount of light that spills.

Snoots

Cones or tubes that creates a small tunnel of light. Snoots are most often used as hair lights, though they can be used any time you need to create a small spot of light.

Grids

Grids, also known as honeycombs, narrow a beam of light, reducing the amount of light that spills. If you notice that a light is spilling onto a black backdrop, add a grid. When shooting high key, use grids to light the backdrop without spilling light onto your subject. Grids are measured in degrees, with smaller degrees producing a narrower beam of light. The following figure shows the light cast by a strobe without and with a 30 degree grid.

Barn doors

Like a grid and a snoot, barn doors are designed to prevent light from spilling into unwanted areas. Barn doors can be individually adjusted to shape light the way you need it. In a pinch, you can tape a piece of cardboard to your reflector to act as a barn door—just make sure it doesn't get too hot.

Scrims

A large sheet of fabric supported by a rigid frame (often made from PVC) that is used to diffuse light. Photographers sometimes use scrims indoors in rooms with direct light, but usually scrims are used outdoors and held between the model and the sun. By casting the model in partial shade and diffusing the direct sunlight, you both soften and reduce the light. Not only does this make the lighting more pleasant on the model, but it's easier to overpower the sunlight with your own flashes. You can buy scrims, but they're also easy to make.

Gobo

A *gobo* (short for "go between") stands between the light and the subject, altering the light in some way. Technically, a scrim is a gobo. Most of the time when photographers use the term gobo, they mean a big piece of cardboard or foam core that blocks light and prevents it from spilling onto something that shouldn't be lit. For example, you might put a gobo between a kicker light and the backdrop to prevent the kicker from illuminating the backdrop.

V-flats

Two large pieces of rigid foam-core board taped together so they can stand freely. 4x8 feet is a great size: taped together, they'll form an 8x8 free-standing and lightweight wall. V-flats are cheap, yet tremendously useful for either blocking or reflecting light. You can buy the foam core you need at craft or hardware stores, though it can be difficult to find large enough sizes. If you cover one side of the v-flats with black, you can use that side to absorb light and prevent it from reflecting back.

Figure 6-40 shows several of these light modifiers. Of these different light modifiers, everyone should start with a big soft box,

a snoot, and a reflector. If you enjoy portrait work, you should definitely get a beauty dish with a grid and a sock. As you use your studio lights, you'll no doubt discover that you need the other modifiers at some point to get the lighting you imagine.

Backdrops

Backdrops provide a perfect, non-distracting for portraits, product photography, and other commercial work. Regardless of the size of your studio or the quality of your gear, a simple backdrop creates instant, professional results.

Backdrops are available in a variety of different sizes and made from many different materials. The sections that follow provide more information about backdrops.

> **Tip:** If you have a dedicated studio, paint the walls and floor a bright white color and use that as the default backdrop. While you're at it, paint the ceiling white, too: it'll soften the light in the entire room. If you're really committed, build a cyclorama wall, which provides a seamless connection between wall and floor. For complete details, watch "How to Build a Cyclorama Wall" at http://vimeo.com/16778474.

Paper Backdrops

Paper backdrops are the least expensive, costing $20-$40 for a roll. You can buy big rolls of paper—usually white or black—and either suspend it from a stand system (costing around $70) or just tape it to a wall. The rolls are usually 6 to 9 feet wide and quite heavy, however, so be prepared to store and transport the roll.

The paper will probably get creased and marked during the photo shoot, and re-rolling paper after a shoot is near impossible, but it's cheap enough that you can just tear off what you use and throw it away afterwards.

Paper backdrops provide a solid, smooth background that you just can't achieve with cloth. For that reason, paper is perfect when you need a solid white background for web images. Once you have a picture with a solid white background, it's easy to change the backdrop to anything in Photoshop: transparency, a different color, a texture, or even another photo.

To prevent a white backdrop from appearing grey or showing the model's shadow, point one or two strobes at the backdrop. Ideally, the entire backdrop will be slightly overexposed, so make sure the background is blinking in your camera's display after you take the picture.

Vinyl Backdrops

Vinyl backdrops are a worthwhile upgrade to paper backdrops. They're several times more expensive than paper, costing around $150 for a traditional 8x20 foot backdrop. While paper is disposable, vinyl backdrops are more permanent. Rather than throwing them away when they get dirty, you can clean them.

Vinyl backdrops are less likely than paper to wrinkle, which allows you to produce cleaner pictures. Any wrinkles you do get will disappear after a few days of hanging.

Cloth Backdrops

Cloth backdrops, including muslin and canvas, are the traditional choice for portrait work. They're so traditional, in fact, that they seem a bit cheesy and dated nowadays. Nonetheless, cloth backgrounds are still the choice for many school and business photos.

Cloth backdrops always provide a texture, even if they're solid white. To minimize the texture, leave at least four feet between your model and the backdrop. To prevent shadows and to create a pleasing halo effect behind the model, point a strobe at the backdrop behind the model's head.

Cloth backdrops are more expensive than paper, running $50 to $200 depending on the size. You'll also need to spend about the same amount on a stand system to suspend the backdrop—they're typically too heavy to tape to the wall.

Cloth backdrops are far more portable than paper because you can fold them up into a small space and toss them into your bag. However, you might also have to bring an iron to steam the creases out of the backdrop.

Collapsible, Portable Backdrops

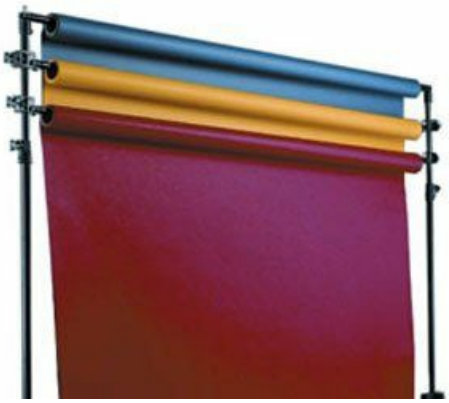
If you don't have room to store a paper backdrop, but you want a flat background, you can buy portable backdrops that fold to less than one-eighth their full size. These backdrops are also useful if you travel to a client's home or office and you want to be able to provide a clean background.

While useful, these expandable backdrops are less than ideal. Though they have a frame designed to stretch the background fabric, the fabric will still be wrinkled. That doesn't have to ruin the picture, but it is a challenge to make the wrinkles not appear in the pictures. If you're shooting a white background, shine a light directly on it to completely overexpose it. If you're shooting a black background, make sure no light falls on it so that the backdrop disappears.

Backdrop Support Systems

Of course, you'll need a way to support your backdrops. Most backdrops come on a roll that allows you to place a pole inside and support it from either end.

Backdrop supports can be portable and temporary (shown first), or fixed and permanent (shown second). If you have a permanent studio space, attaching backdrop supports to your wall or ceiling makes backdrops much easier to extend and collapse. Permanent supports also decrease the chance that a child or clumsy photographer will knock over one of the poles, causing the entire system to collapse and possibly ruining your backdrops.



If you do use a temporary backdrop support system, be sure to place sandbags over the base of the supports to make them more stable. You'll probably also need a clamp to stop the paper from unrolling.

Light Stands

Lights, reflectors, and even your computer can be attached to light stands. Light stands are like tripods with a narrower base. You can spend anywhere from $20 to $7000 on a light stand, depending on the weight, features, and strength.

Your first lighting kit will come with cheap light stands. As you add more lights, you can buy better quality light stands. Better quality light stands are cushioned, which makes it easier to adjust the height without jarring the strobe and possibly breaking the bulb.

Monolights and strobes are ready to be mounted directly to light stands. Flashes, however, are designed to be mounted to a camera. To mount a flash to a light stand, you will need to use a *flash light stand adapter* (about $20-$30). Choose one that provides a place to mount an umbrella.

Folding light stands

Traditional light stands have three legs that fold for storage or travel, like a tripod with short legs and a very long center column. These light stands are sufficient for most studios. If you frequently move them, you might consider adding casters (wheels) to allow you to roll them. Like all light stands, you should have a sand bag on them to reduce the risk of the stand falling.

C-stands

C-stands have fixed, rather than folding legs. However, they can be disassembled for travel. They also tend to be sturdier and heavier than folding light stands.

C-stands are better than folding light stands. Unfortunately, they're also much more expensive. An 8-foot C-stand will cost $120 to $250, whereas a similar folding light stand might cost $15-$25.

C-stands are a good investment for studios that receive heavy, constant use. Folding light stands can be fidgety, and a C-stand pays for itself if it saves a single broken light.

Microphone stands

At the other end of the spectrum, microphone stands can be used to support lights or cameras (though you might need an adapter, depending on the threading). Microphone stands can be found slightly cheaper than light stands (as low as $10 each), but the primary benefit is reduced footprint. Microphone stands have a heavy base that's smaller than a folding light stand, providing stability while allowing you to more easily navigate around your lights in a very small studio.

Booms

Once you get some practice with standard light stands, you'll discover something frustrating: If you want a light directly in front of your subject, the light stand will be in the way of your shot. Booms work around this by hanging the light out on a long arm. I use a *CowboyStudio boom*, shown in Figure 6-38, that costs about $70. While it's inexpensive, it's only suitable for lightweight flash heads and light modifiers; heavier modifiers like large *beauty dishes* will cause the boom to twist. Booms are particularly unsteady, so use *sandbags* to both balance the boom and keep it from falling over.

You will need to put sandbags over the base of your light stands (especially booms). Sandbags are surprisingly expensive, but if you don't use them, it's only a matter of time before you knock a light stand over. When that happens, you'll definitely break a bulb (which is expensive to replace). You might also knock over other light stands, damage your backdrop, or hit a person—possibly burning them.

If you use your studio regularly and you have flat, hard floors, put some wheels (known as casters) on them. Casters allow you to more easily move your lights, especially if you have them properly sandbagged.

Apple Boxes

For a traditional portrait, the lens should be slightly above the model's eye level. This is going to be a problem unless every model is about four inches shorter than you.

We studio photographers use apple boxes to change either the subject height or the model height. If the model is more than about six inches shorter than me and I don't want to kneel or crouch, I'll have the model stand on an apple box. If the model is my height or taller, I'll stand on the apple box.

Apple boxes are also critical for equalizing height in family portraits. Have shorter subjects stand on boxes so the height differences are minimized.

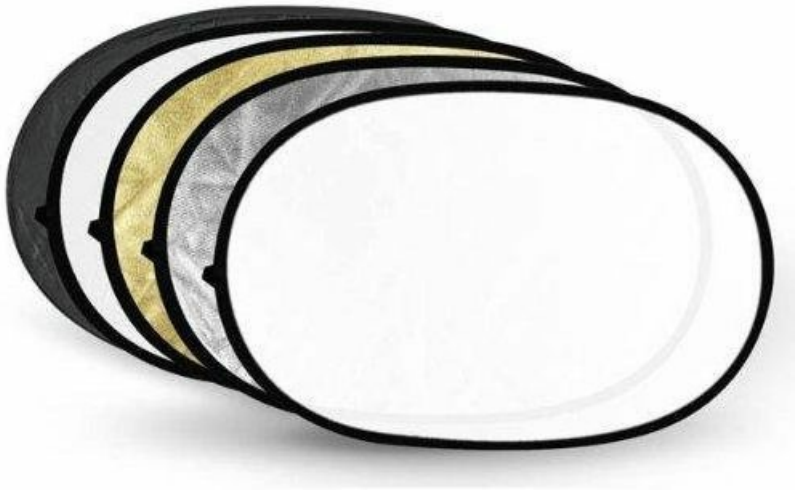
You'll need apple boxes in at least three sizes so that you can adjust heights differently. Naturally, you can stack multiple apple boxes as needed. In a pinch, you can use large books, cinder blocks, or bricks.

Posing Stools

Stools used to be a standard element in a photography studio. Nowadays, however, most models simply stand (for an individual portrait) or kneel (for group photos where you need to equalize height). Stools are still useful for children, however, because having a child sit on a stool helps to keep them in a single place. Stools are also useful as an alternative to apple boxes for adjusting the height of your subject.

Posing stools should rotate, have adjustable height, and have a foot rest and wheels. They shouldn't have a back (which might appear in pictures).

Reflectors



Reflectors bounce light. In a studio environment, photographers often use a reflector as an inexpensive fill light, to reduce shadow depth.

Reflectors are commonly white, silver, or gold. White reflectors add a diffused fill light. Silver reflectors add more light, but the shadows won't be as even. Gold reflectors add a touch of gold color to the light, which might make some skin tones more appealing. I typically use a white reflector first, and switch to a silver reflector only if the white reflector doesn't add enough light. I'll only use a gold reflector if my model has an extremely pale complexion.

Fans and Wind Machines

Fans blow the air around, creating movement in the model's hair. A little bit of wind almost always improves photos of subject's with longer hair. It also helps to keep the model cool under the lights. Any standard pedestal fan is good enough for hair.

You can use more powerful wind machines or even an electric leaf blower to add movement to dress fabric.

Tethering

Some photographers keep a computer in their studio and tether their camera directly to it. Tethering allows you to instantly review your photos on a larger screen. When working with Adobe Lightroom, you can even automatically apply some processing to the pictures to better assess the final image.

Tethering is also useful in larger studios with a separate art director. The art director can examine the photos as they are shot, providing instant feedback to the photographer (without having to look over the photographer's shoulder at the back of the camera).

Most cameras can be tethered using Wi-Fi, possibly with a special SD card such as an Eye-Fi card. However, wireless tethering is too slow to be useful in most environments. For tethering to really be useful, you need a camera with wired Ethernet, such as a Canon 1DX, Nikon D4S, or most medium format digital cameras.

I almost always prefer not to tether when shooting in the studio. Being able to see pictures distracts models and can make them self-conscious. Instead, I prefer to select the best photos and show them to the model on the back of the camera.

Remote Shutter Release

You can use a wireless remote shutter release to trigger your camera while you move around your studio. Obviously, this would only be useful if you had a still subject and had your camera on your tripod. However, that's a common scenario in traditional portrait photography.

Being able to move away from your camera can speed up portraits when working without an assistant. You can adjust a light or your model's hair and instantly take a sample photo without walking back to your camera.

You should only purchase a radio frequency (RF) remote shutter release. Infrared remote shutter releases are too unreliable to be useful.

Chapter 9: Tripod and Monopod Buying Guide

Tripods steady your camera, allowing you to walk away from the camera to pose models, adjust lights, or take a self-portrait. They're also required for long exposures that would induce camera shake, such as pictures taken at night or during the day with a neutral density (ND) filter.

This video provides a quick overview of the tripods Chelsea and I use, along with the features that differentiate them.

The sections that follow provide my quick recommendations for those who want to buy quickly, and then detailed descriptions of different tripod features to help you better make your own buying choices.

Video: Tripods **9:50** *sdp.io/Tripods*	

Quick Recommendations

If you don't want to learn about tripods and just want something to stick your camera on, here are some quick recommendations for those of you primarily shooting still photos:

- **Cheap first tripod:** ***Dolica GX600B200 ($47)***. This ball head tripod extends to five feet, making it suitable for photographers up to about 6 feet tall. It has flexible legs that allow you to get low to the ground, and has a hook that you can hang your bag from to make it more stable. It's small and light enough to travel with. If you're over six feet tall, buy the 65-inch version.
- **Mini tripod:** ***Pedco UltraPod II ($17)***. There are dozens of mini tripods available, but this model has Velcro that allows you to strap it to poles or branches, giving you a higher viewpoint. It's not sturdy enough for a heavy lens, however.
- **Smartphone tripod mount:** ***i.Trek Super Mount F ($19)***. These versatile mounts work with any camera phone, making them more versatile than the phone-specific models. I carry one of these with me even when I have my DSLR, because it's a great backup.
- **Professional travel photo tripod:** ***Manfrotto MK293C4-AORC2 ($280)***. Most people won't ever need a professional tripod, but if you're finding your cheap first tripod a bit too cheap, this tripod is light, sturdy, and repairable. The center column can turn horizontal or upside-down, making it perfect for macro work. You can also replace the head, so if you decide later you want a proper video head with fluid pans and tilts, you can still use the same legs.
- **Professional travel video tripod:** ***Manfrotto MVH500AH 755CX3 ($680)*****.** The 755CX3 has a levelling center column that works wonderfully for quickly setting up on uneven ground. For a carbon fiber tripod, the sticks are a good, solid weight.
- **Professional studio video tripod:** ***Manfrotto MVH502A 546BK-1 ($580)*****.** This tripod completely lacks a center column, but still sets up quickly. The ball mount allows you to quickly level the head, just like a levelling center column. The MVH502A fluid head provide silky smooth pans and tilts.

Types of Tripods

Because photographers shoot different subjects in different conditions, there are many different types of tripods. The sections that follow describe the most common types.

All-in-One

The least expensive and most portable tripods are all-in-one tripods that have the legs and heads permanently connected. These

tripods are the right choice for most people's first tripods. Once you've spent some time with your all-in-one tripod, you might discover that you wish it's missing some feature you wish it had, such as a different type of head, or more height. However, the money you spent on your first all-in-one tripod won't be a waste, especially if you buy a decent quality all-in-one tripod.

Travel

Travel tripods compromise functionality for portability. Typically, they're quite small, which makes them easy to store in a bag. I look for a travel tripod that fits vertically in my carry-on bag, without having to angle it sideways, where it would consume too much space in my bag.

Inexpensive travel tripods are made from plastic, while the higher-end travel tripods are made from carbon fiber. Either way, they're likely to be light enough that you'll want to anchor the tripod for long exposures, such as those taken at night.

Studio

Studio tripods are strong, sturdy, and heavy. They're definitely the best type of tripod to use, but they tend to be too cumbersome to travel with.

Everyone needs at least one travel tripod, and your travel tripod will probably be good enough for most uses around the house and in studio. Therefore, I recommend starting with a travel tripod, and if it isn't study enough, purchase a separate studio tripod for use when you don't mind the size and weight.

Pocket

Pocket tripods are optimized only for portability. Typically, they stand only 4-8 inches tall, and are used for taking quick self-portraits. Because they're so low, they're not designed for standing on the ground—you'll need to find a table you can rest them on. They also don't extend vertically, so how high or low your camera is held will be determined entirely by where you rest the tripod.

The problem with this is that you typically rest them on a table or counter, which is below eye-level. For self-portraits, this results in an uncomfortably low perspective that shows the underside of everyone's chin, making people seem heavier than they are.

Pocket tripods are fairly useless except that you can literally keep them in your pocket or bag, so they're great for carrying with you everywhere. There's an old saying, "The best camera is the one you have with you." The same applies for tripods.

Note that most pocket tripods aren't strong enough to support a full-sized DSLR and lens. They're best used for small mirrorless cameras, point-and-shoot cameras, or camera phones.

Monopods

Monopods are tripods with a single leg. They support the weight of your camera and virtually eliminate any camera shake, however, you can't walk away from your camera. They're much lighter and easier to carry than a tripod, making them ideal for wildlife photographers who tire when holding a large telephoto lens, as shown in the following picture.

Many photographers will also use a monopod in the studio, because they eliminate camera shake while allowing them to move around the studio more freely.

I personally almost never use a monopod. However, my wife, Chelsea, is much smaller than I am, and can get tired when using telephoto lenses. Therefore, she prefers to use a monopod in the studio. As small as she is, Chelsea still hates using a monopod for wildlife, because it limits your ability to follow flying birds.

Specialized

You can also buy several types of specialized tripods. The two types I commonly use are:

Suction cups. You can use suction cup tripods to mount your camera to a car or glass—these are extremely useful for video inside or outside of a moving car. That sounds scary, but I've spent hours driving with cameras stuck to the inside and outside of my car, at highway speeds, and never even had a close call. *Fat Gecko* makes a series of excellent suction cup tripods. Use them at your own risk, however!

Flexible legs. *GorillaPod* makes a series of tripods with legs that are so flexible you can bend them into any shape you want, or even wrap them around a pole. While cool, I don't find myself using them very often.

These are just two examples—you can purchase specialized tripods that allow you to stabilize your camera in just about any situation.

Legs/Sticks

Tripods have three legs, or as videographers call them, "sticks." The sections that follow discuss the qualities different legs have.

Height

Ideally, a tripod will extend high enough that you'll be able to look through your camera's viewfinder without crouching down. That doesn't mean that the legs need to extend to your standing height. Typically, you can buy legs about a foot shorter than you are and be quite comfortable.

The height of the legs isn't the height of your viewfinder. On top of the legs, you'll add a head, which is typically 4-6 inches high. Additionally, your camera's viewfinder is usually 3-4 inches above the head.

For ideal comfort, I recommend getting legs that extend to about 8-12 inches shorter than you. If you get a taller tripod, it'll be unnecessarily large and heavy. However, I have at times extended a tripod far above my own head. For example, I'll extend my tallest tripod very high when shooting over a crowd. That's a really useful technique when shooting firework shows.

Segments

Most tripod legs have either three or four segments. Legs with four segments allow the tripod to fold smaller and extender longer, but the legs themselves are flimsier. Legs with three segments don't extend as far, but the legs are sturdier.

Therefore, travel tripods typically have four segments, whereas studio tripods typically have three.

Materials

Tripod legs can be made of several different materials, each with their own advantages:

- **Plastic**. Plastic is lightweight and inexpensive. For this reason, it's very common on tripods priced under $30. Unfortunately, plastic tends to be rather flexible, which can cause your camera to wobble a bit, especially in the wind. Nonetheless, a plastic tripod is just fine for taking pictures in daylight or with flash. If you just plan to take some self-portraits, a plastic tripod is perfect. However, if you plan to do long exposures (such as those involved in night photography), a plastic tripod will result in many photos ruined by camera shake.
- **Metal**. Mid-range tripods and studio tripods are often made out of some form of metal, often aluminum. Metal is much more rigid and heavier than plastic, making it ideal for long exposures. When I don't have to carry the tripod somewhere, I always prefer a metal tripod.
- **Carbon fiber**. The most expensive tripods are made from carbon fiber, because it's more rigid than metal, and as light weight as plastic. For that reason, carbon fiber tripods are ideal for travel and hiking. However, the light weight means they can shake in the wind. If you do buy a carbon fiber tripod, look for one with a hook that allows you to hang a bag from the center column. The bag will increase the weight of the tripod, reducing the shakiness.

Clasp Types

Legs must lock into place after you extend them. Clasps are either switch-type or screw-type. I find the switch type clasps to be much quicker and more reliable, therefore, I always look for legs with switch-type clasps.

Center columns

Most tripods have an extendable center column. Typically, you'll extend the legs as a group to about the right height, and then adjust the individual legs to level your tripod on uneven ground. Then, you'll extend the center column so that your camera is at the perfect height.

Center columns have different features, too:

- **Removable**. Some tripods, especially travel tripods, have a removable center column that allows you to extend the center column sideways or even completely upside-down. These are very useful for macro/close-up work, but they're rarely useful for other types of work. Though you won't need the feature often, when you need it, you really need it.

- **Leveling**. Center columns used for video allow you to quickly level the head after you've extended the legs. If you're using a ball head, this isn't useful at all. However, if you're using a pan/tilt head for video, a leveling center column is critical. While you could adjust the length of the individual tripod legs to perfectly level the head, this is difficult and time-consuming. With a leveling center column, a perfectly level head is only a couple of twists away.
- **Hook**. Center columns with a hook on them allow you to hang a bag from them, adding weight and stability to your tripod. This is a great, but unfortunately rare, feature to have.

Center columns are usually included with the tripod legs because there's no standard way to attach a center column to legs. Therefore, you should consider the capabilities of the center column when choosing legs.

Heads

The tripod head attaches to the top of your legs and provides a connection to your camera. The head gives you the ability to pan, tilt, or twist your camera in different directions without moving the legs. The sections that follow describe different characteristics of tripod heads.

Size

Tripod heads of any type are available in a wide variety of sizes and weights. Smaller heads are obviously better for travel, however, they're also much less sturdy. If your head is too small for your camera weight, it might not hold your camera in place, especially if you have it tilted at an angle or if you're using a large lens.

A bigger head is always preferred when you're taking a photo. They're easier to use and they won't drift as gravity pulls on them. However, they cost more, weigh more, and take up more space in your bag.

For studio tripods, get the biggest head you might ever need. For travel tripods, choose a head just large enough to support the camera and lens you intend on using. Tripod heads typically list a weight that they're rated for, so weigh your camera, lens, and flash, and choose a head that can support that weight (plus a pound or two).

Quick Release Plate

Quick release plates (QRPs) attach directly to your camera, and allow you to quickly attach and detach

your camera. With the exception of pocket tripods, I would never recommend a head without a QRP. Fortunately, all tripods with separate heads include a QRP, and only the least expensive all-in-one tripods lack a QRP.

If you purchase multiple heads, choose heads with the same QRPs so that you can easily move between them. It also helps to purchase extra QRPs and keep them in your bag, because it's very easy to lose or forget a QRP, and then you'll be unable to connect your camera to your tripod.

Ball Heads

Ball heads allow you to twist and turn your camera in any direction, including turning it 180 degrees to take a vertical picture. Ball heads are the standard choice for still photography.

There are dozens of variations on the ball head. Most have a knob that loosens the ball head to allow you to adjust the camera angle, and then re-tighten it so the camera stays in one position.

Joystick Heads

Joystick heads are a type of ball head designed for one-handed operation. With a typical ball head, you must turn the knob with one hand, and adjust your camera with the other hand. With a joystick head, you just squeeze the switch and adjust the head with a single hand.

I generally dislike joystick heads because they tend to be unnecessarily large. However, if you're doing night photography (where you might have a flashlight in one hand) they can make the process much easier.

Pan and Tilt Heads

Pan and tilt heads separate horizontal movement (panning) from vertical movement (tilting). This allows you to level your tripod,

For video, look for a fluid pan and tilt head. Fluid heads allow you to pan and tilt much more smoothly while recording. If you plan to take only stationary shots, you don't need a fluid head.

Hybrid Heads

Hybrid heads attempt to provide both ball head flexibility with pan-and-tilt capabilities. There's a switch that switches the head between ball head mode (for still photos) and pan-and-tilt mode (for video).

I've tried several different hybrid heads and haven't liked any of them. They're a jack-of-all-trades and master-of-none, and are frustrating whichever mode they're in. They also tend to be more expensive than good examples of either ball heads or pan-and-tilt heads.

Therefore, I recommend avoiding hybrid heads and purchasing separate heads for different uses. Swap your heads out as needed; it's rarely necessary to quickly switch from a ball head to a pan-and-tilt head.

Gimbal heads

Gimbal heads are designed for use with large telephoto lenses, such as a 300mm f/2.8, 400mm f/2.8, 500mm f/4, or 600mm f/4. Gimbal heads balance these large, heavy lenses better by attaching either at the side or from above.

The advantage of gimbal heads is that your tripod stays better balanced as you tilt your camera and lens up or down. With a traditional ball head, tilting a heavy lens would cause the entire tripod to be off-balance, potentially knocking it over, causing all your expensive gear to crash to the ground.

Many wildlife and sports photographers use gimbal heads. Even though I often use a very heavy 500mm f/4 lens, I don't like gimbal heads for most wildlife work, because I prefer to hand-hold my lens so that I can easily turn to the side or lift the entire camera up.

However, gimbal heads are a necessity if you're going to be staying in one place, and you know approximately where your subjects are going to be. This makes them perfect for professional sports work, where you will be assigned a position along the sidelines, and you will need to stay in that spot for hours at a time. In that situation, hand-holding a heavy lens would be impossible. They're also useful for wildlife photographers who are camouflaged and waiting for an animal to appear at a specific location.

Miscellaneous Features

Some tripods offer these features, which vary in usefulness:

- **A level**. In theory, a level allows you to guarantee a straight horizon, which is critical for video and quite important for photography. However, a level that's attached to the legs is usually quite useless, since the head itself might not be level with the legs. Don't bother with tripod legs that have a level—instead, look for a head that has the level built into it, or just use the level that's built into most new digital cameras.
- **Carrying straps**. If you plan to travel with your tripod, a strap that allows you to carry it is extremely useful.
- **Hooks (or attachments for carabineers)**. I love tripods that have hooks or places to attach a carabineer, because they allow me to more easily attach the tripod to a bag when carrying it.

Chapter 10: Computer Buying Guide

The more serious you get about photography, the more time you spend editing your photos, and the more time you spend waiting for your computer to perform different photo editing tasks. If you're buying a new computer, it makes sense to choose one that will be particularly quick when editing photos.

However, most new computers can do an excellent job with the two most popular applications, Adobe Lightroom and Photoshop. If you're happy with your PC's performance, there's no need to upgrade. However, if things seem slow, or you plan to upgrade your PC anyway, the sections that follow will give you the general background information you need to make educated choices.

As with the rest of this book, my goal is not to simply list all the highest-end equipment to setup the ultimate workstation. Instead, my goal is to get you the most editing power for whatever your budget is.

Quick Answers

The sections that follow provide more detailed information for technical readers, but these tips tell you most of what you need to know:

- **Get at least 4GB of RAM**. More is better, however.
- **Get the fastest processor you can.** Processing power is very important for photo editing.
- **Get an SSD (Solid State Drive) and a PC that supports SATA 3.** SSDs greatly decrease the time it takes to open and save your photos. They're expensive, though, so you might consider getting a high capacity non-SSD drive, such as a 3TB or 4TB drive, and moving your pictures to it after you're done editing them. Lightroom will store your previews on your SSD drive, allowing you to quickly view those images.
- **Get multiple monitors.** Two monitors makes using Lightroom much easier, because you can preview the full-size version of your picture on the second monitor. If you have a laptop or other mobile PC, you can connect it to an external monitor or TV and use that as your second monitor.
- **Get big, cheap monitors.** Calibrated monitors are for professional designers who have their own professional printing equipment. Most photographers don't need to calibrate their monitors, and professional monitors are nice, but unjustifiably expensive.
- **Don't waste money on a graphics card.** Any basic graphics card will do. Expensive graphics cards are for gamers, not for photo editing.
- **Get a desktop.** Unless you absolutely need to edit photos while traveling, a desktop always provides better performance than a mobile PC (for similar budgets). Desktops are also much easier to upgrade and repair.
- **Backup your pictures.** Hard drives fail and computers get stolen. If you don't backup your computer, you will lose everything. Online services such as Carbonite.com and Mozy.com will backup your entire PC across the Internet (for a fee). You can also buy an extra drive and back your pictures up to it using the backup software included with your operating system.

Mac or PC?

Either Mac OS or Windows will work fine, and Lightroom and Photoshop function exactly the same on either operating system. Macs are lovely, but they tend to be more expensive for similar performance. Windows 7 and Windows 8 have solved the biggest complaints people used to have about Windows—that it was unreliable and prone to security problems. If you don't have a particular love for Macs, get a PC.

If you're looking for a laptop, the guidelines discussed in this chapter apply to laptops, too. One particularly important consideration is the resolution of the screen. The higher the resolution, the sharper your pictures will be while you're editing them. Also look for laptops with SSD drives and an i7 processor.

Avoid ChromeBooks. While they're great for what they are, they don't run Lightroom or Photoshop.

Here are some specific recommendations at different sizes:

- **Small 13” ultrabooks.** Consider the *Samsung ATIV 9 Book Plus* ($1400) with an amazing 3200x1800 screen. The *MacBooks with the Retina displays* are amazing for photo editing on-the-go, too.
- **Standard 15” laptops.** For this size, the *15” Macbooks with Retina displays* are the best choice.

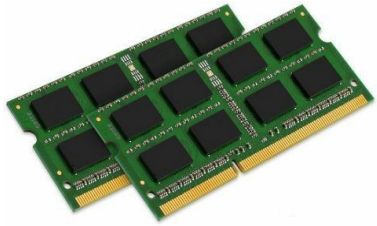
Choosing Computer Components

Designing a computer for a particular task involves determining which of the computer components are limiting (also known as bottlenecking) the performance of that task. For image editing, three components equally limit your overall performance:

- **Disk speed**. When you edit a picture, the computer has to read it from the hard disk and copy it into RAM. When sorting through hundreds of pictures after a photo shoot, the disk speed is going to be the biggest factor slowing the process down. Therefore, a fast disk (and a fast disk subsystem, which connects the disk to your other computer components) is critical.
- **Memory (RAM)**. After your computer copies the picture from the disk to memory, it will need to work with the memory each time you view or edit the picture. Faster memory will significantly improve the performance while working with a single picture, and you need sufficient memory (4GB or more).
- **Processor**. Processing RAW files, and applying edits to a picture, requires a great deal of processing. Any processor will eventually get through your edits, but the faster your processor, the quicker the edits will take place. It’s worth it to spend more to get a faster processor.

The sections that follow describe these components in more detail, and provide information about several less-critical components.

Memory (RAM)



RAM (Random Access Memory) is the temporary storage that computers use to store information while an application is actively working on it. RAM gets cleared every time you restart your computer. Everything that survives a reboot, including your pictures and videos, is stored on your hard drive.

Capacity

For photo editing, 4GB of RAM is typically sufficient. Monitoring my own PCs during extensive photo editing sessions, and working in Photoshop with multiple RAW files and dozens of layers, shows that Photoshop and Lightroom rarely use more memory, anyway.

If you plan to record and edit video, choose a computer with at least 8GB of RAM.

While those recommendations are sufficient, more RAM is always better. Your operating system (whether Windows, Mac OS, or something else) will use the additional RAM to help improve your computer’s overall performance. However, you will see minimal performance gains upgrading from 8GB to 16GB of RAM.

RAM typically costs less than $10 per GB when purchased after-market. When you buy a new PC with extra RAM, the PC manufacturer can drastically overcharge you—often charging over $40 per GB. Therefore, I typically recommend purchasing a new PC with the minimum amount of RAM, and then upgrading your memory after you receive your PC. Even if you’re not a computer nerd, you’re quite capable of upgrading the memory in any desktop computer. Mobile computers are often very easy, too, though some are not designed to be upgraded.

Speed

The speed of your memory is very important, though the speed of your memory is determined by your motherboard. Always purchase the fastest memory supported by your motherboard. When purchasing a new computer, or a separate motherboard if you’re building your own computer, it’s worth spending a bit more to get a PC that supports faster memory; that upgrade will give you very real performance improvements when editing pictures.

Processor

If you spend time editing individual pictures (rather than simply sorting through them), processor speed will be very important. Simple edits like crops and adjusting brightness don't require much processor time, but complex effects like healing spots, changing the perspective of a picture, changing the background, or using warp and puppet effects require a great deal of processor time.

Therefore, if you only perform light editing on your pictures in Adobe Lightroom, a faster processor might not make a huge difference. However, if you use healing or more intensive Photoshop features, investing in a higher-end processor will be worthwhile.

If you take RAW pictures instead of JPG, and you should take RAW pictures, your computer will need to do a great deal of processing when you first open your pictures. Therefore, RAW files justify a higher-end processor.

Measuring processor performance is complex, because there are several different factors:

- **Bus speed**. This is the speed at which the processor can exchange information with the computer's memory.
- **Processor speed**. This is the speed (typically measured in GHz) at which the processor performs operations.
- **Cores and hyper-threading**. Modern processors have multiple cores, which is like having multiple different processors. Essentially, this increases the processors speed, but only for some activities.

To make it easy, choose i7 processors over i5 processors, and get the fastest i7 your budget allows.

Disks

Get two disks: one small SSD and one high-capacity drive. Install Windows or Mac OS and your apps on the SSD drive, and use it to store your newest pictures. When you start to fill up your SSD drive (which only needs to be about 256 GB), move your pictures to your high-capacity drive (which might be 3 terabytes or more). Because your high-capacity drive is only used for long-term storage, it doesn't need to be fast.

It's very important that your computer support SATA3. SATA2 is not fast enough to take full advantage of the newest SSDs.

Monitors

Get two monitors. Having dual monitors really helps with applications such as Lightroom, because you can view thumbnails of your library on one monitor and view images full-screen on your second monitor. For photo editing, I'd

rather have two smaller monitors than one bigger monitor.

For me, more than two monitors doesn't increase my efficiency. When I've used three or more monitors in the past, I never fully utilize them—there's simply too many different screens for me to use efficiently.

The higher resolution the monitors are, the better. Higher resolution screens will allow you to see more detail in your pictures without zooming in, which can greatly speed up the editing process.

Here are specific recommendations at different price points. If you decide to use two monitors, it makes it much easier if they're identical:

- *Dell S2240M* ($130). My producer uses this two of these 22-inch monitors (1920x1080) to edit video, and the glossy screen is bright and beautiful.
- *Dell S2740L* ($265). This 27-inch monitor is a great value and has a beautiful display.
- *Dell 3014* ($1100). If you'd like to freak out nerds who visit your house, get two of these 30-inch monitors. I use an older version, and combined they're just amazing for image and video editing. The 27-inch models are almost as large at one-quarter the price, however.

Don't spend money on calibrating your monitors, or on buying a professional monitors like the *NEC Multisync* series. Calibrated monitors aren't for photographers, they're for designers and those in the printing industry. Even if you print your own photos at home, calibration will only make a difference if you have a professional-level printer and you calibrate it to your display.

If you primarily share your images digitally, the people viewing your pictures won't have calibrated monitors. They'll be using smartphones, tablets, and other devices. They'll be viewing your pictures in different lighting conditions.

Instead of calibrating your monitor, carefully set the white balance of your pictures by choosing a custom setting based on a white object in the photo itself. That's the only way to ensure your pictures have the proper color. Also, be sure to check the histogram to ensure your image is bright enough. For detailed information, refer to Chapter 4 of Stunning Digital Photography.

Memory Card Readers

Most photographers copy their pictures from their camera to their computer by using a memory card reader. The memory card reader itself isn't particularly important, but you should choose a USB 3 memory card reader so you can copy pictures as fast as possible, because I know you'll always be eager to see the pictures you just shot. Also be sure that a new PC supports USB 3. Many new PCs only support USB 3 on select ports (usually colored blue); other ports might use USB 2 (usually colored black). Therefore, be careful to connect your USB 3 memory card reader to a USB 3 port.

Many PCs and some monitors have memory card readers built-in, and that's definitely a convenience. However, the built-in memory card readers might not be as fast as an external USB 3 memory card reader.

Video Cards/Graphics Cards

As I mentioned earlier, video card performance isn't a significant factor in photo editing performance. Some Photoshop effects are capable of taking advantage of your video card's graphics processing unit (GPU), but they're not effects that most photo editors use on a regular basis.

However, you should be sure to choose a video card that can connect to your monitors. Specifically, choose a video card that supports connecting to multiple, high-resolution monitors simultaneously. Look for multiple DVI ports, and possibly an HDMI port if you plan to connect your computer to a TV.

Drawing Tablets

Some people like using tablets to edit their photos. If you like drawing with a pencil, you'll probably like using a drawing tablet. If you're terrible at drawing, like I am, you're probably better off using a mouse.

Wacom makes the best tablets for photo editing. They have several tablets available, at different quality levels and at different sizes. Bigger sizes are nicer to use, but don't choose a size that's too big for your desk.

In order from least to most expensive, and from least to most powerful, Wacom's current lineup is:

- ***Bamboo*** **($80-$100)**. Designed more for fun than work, these are good enough for most photo editing tasks.
- ***Intuos*** **($100-$500)**. The mid-range Intuos tablets are more sensitive and better support varying pressures, which can be useful when drawing with brushes in Photoshop. The Intuos5 and Pro models offer more controls on the tablets themselves, for tasks such as changing brush size. This can improve your workflow and decrease the time you spend editing photos.
- ***Cintiq*** **($1000-$2500)**. This high-end line combines monitors with drawing tablets, allowing you to draw directly on the screen. It's not as great as it sounds, however, because your hand covers part of the screen as your drawing. Many people prefer using a separate monitor and tablet.

Chapter 11: Underwater Photography Buying Guide

Whether you want to grab snapshots of their kids in the pool or create ethereal underwater portraits, you'll need to gear to protect your camera. This chapter provides an overview of the different options available for all different budgets.

Video: Underwater Gear 13:19 sdp.io/underwater	

Equipment

Your first choice is to either buy a new camera specifically for underwater use (for as low as $10) or to buy an underwater housing for a camera you already own. Either way, your gear should:

- Allow you to grip the camera while swimming.
- Allow you to see the viewfinder and/or the LCD screen.
- Replicate the buttons on your camera so you can focus, zoom, and change settings underwater.
- Keep your camera dry.
- Float when you drop them.

Disposable Film Cameras

The cheapest way to grab underwater photos is to use a disposable film camera ($7-$20, plus developing costs). It will seem primitive; there's no LCD display, and you'll need to wind the film manually between each shot. The camera won't even have a focusing system. After you take the photos, you'll have to find a store that still develops film, or send your film to an online service (such as thedarkroom.com).

It's inconvenient, but it's not a bad idea for a vacation. You don't have to worry about ruining an expensive camera, and while the quality won't be great, underwater photos rarely have great quality.

Waterproof Sports Cameras

Sports cameras have become very popular in recent years. These compact and durable cameras can go almost anywhere, including underwater. While you wouldn't want to make a portrait with them, they're an excellent choice for casual underwater photography.

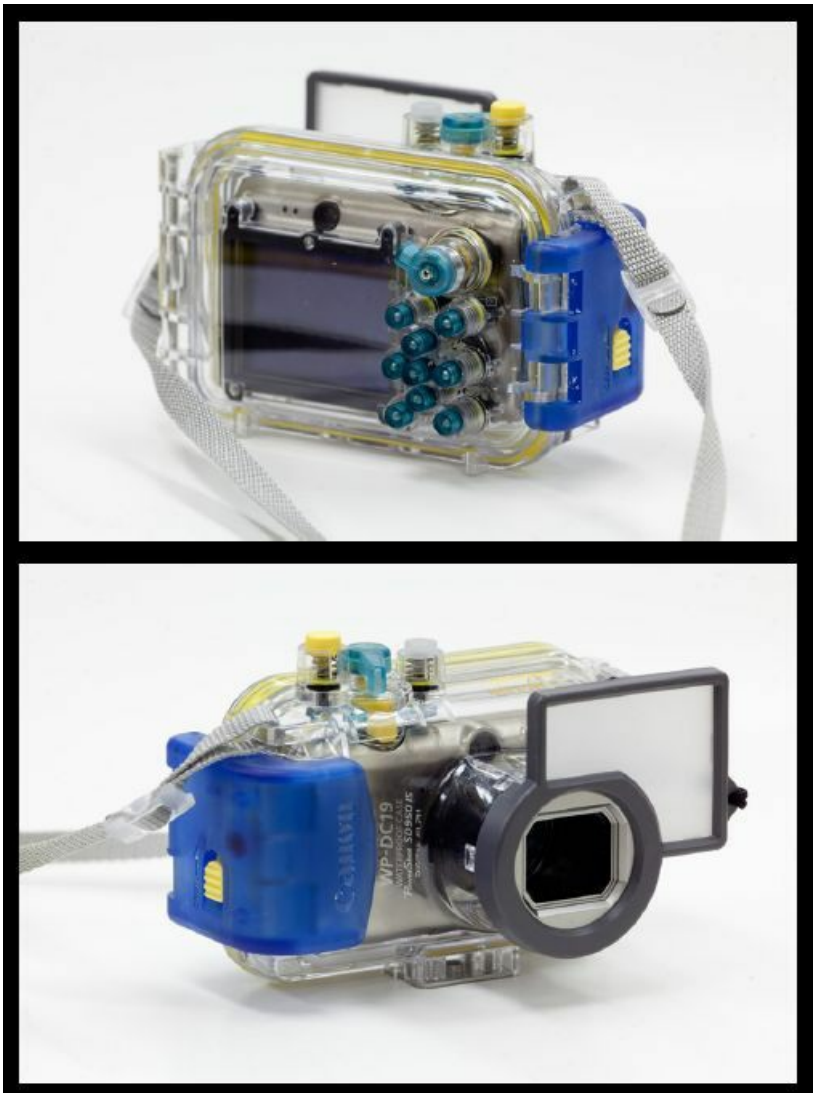
While there are many different models of sports cameras available, the GoPro Hero is my top recommendation. Priced from $200 to $400, all the GoPro models include underwater housings. They're not perfect, however. Some of the challenges are:

- **No viewfinder or LCD display**. Seriously, GoPro cameras do not include an LCD display or a viewfinder. If you want to see what you're taking a picture of, you need to buy the GoPro LCD Touch BacPac for $80. Underwater, the display is very difficult to see. Therefore, I don't recommend it for underwater photography. Instead, I recommend simply pointing the camera in the general direction of your subject, pressing the shutter, and taking as many pictures as you can. It sounds ridiculous, but it works better than using the LCD.
- **An extremely wide-angle lens**. The GoPro lens is essentially a fisheye lens, capturing an incredibly wide-angle view. This is both good and bad. It's very hard to compose a picture carefully underwater, so the fisheye lens ensures you capture everything around you, and you can crop the picture later. The downside of the lens is that you need to be very, very close to your subjects to see much detail. Ideally, you would be about 18 inches (half a meter) away. Most marine life won't let you get that close.
- **Fixed focus**. GoPro cameras have fixed focus. Combined with a super wide-angle lens and a small sensor, they have near-infinite depth-of-field. Everything from about 18 inches away to infinity will be in focus. If you get closer to a subject, it will be blurry. It's not generally a problem with underwater photography, however.

Housing for Point-and-shoot Cameras

You must find underwater housing made for your specific camera model—that's the only way the buttons can be reproduced. Every important button and dial on your camera will have a copy on the outside of the underwater housing, with springs and levers that push your cameras buttons when you push the corresponding button on the camera housing.

The murkiness of water won't allow you to take advantage of your DSLR's high image quality, anyway, so consider starting your underwater photography with an underwater housing for a point-and-shoot camera, as shown in the following figure. Purchase an underwater housing made by your camera manufacturer. Canon, Nikon, Sony, and Fuji all make underwater housings for their popular point-and-shoot cameras. Check eBay and see if you can find a good price on a used housing. If you have a Nikon, *Fantasea Line* might make a housing for your camera.



Point-and-shoot housings typically add a diffusing screen in front of the camera's flash, as shown in the previous picture. This will help just a bit, but they're not bright enough to light up subjects in deep water. Also, because the flash is placed so closely to the lens, you'll get *backscatter*, which causes particles in the water to reflect the flash back to the camera.

If you go any deeper than thirty or forty feet (or less if it is not sunny or the water is not clear), you're going to need *external underwater strobes*, which are flashes that attach to the bottom of the housing using the tripod connector and are triggered when your camera's built-in flash is fired. You might also need to add weights to your case. While having the case float is helpful when you're snorkeling, when you're trying to dive, a floating case will be fighting you the whole way down.

Dedicated Interchangeable Lens Cameras

Nikon makes two interchangeable lens cameras: the film Nikonos (starting at $150 used) and the digital AW1 ($750 new).

Because they're built specifically for underwater use, they're less bulky and easier to use underwater. You can use either camera above water, too, though I'd only recommend them for the most casual above-water photographers.

Housing for DSLRs

Camera makers don't make underwater housings for DSLRs. Instead, check out *Aquatica*, *Sea and Sea*, *AquaTech*, and my favorite (for the lower prices), *Ikelite*. You will need:

- **A housing made for your camera body**. This is the most expensive piece of equipment. When comparing housings from different manufacturers, check that all important buttons are replicated and that you can see the viewfinder and LCD clearly. Housings can be acrylic (see-through plastic, as shown in the following figure) or aluminum. Acrylic lets you see inside the housing, which is nice for making sure the o-ring is in place and that the case isn't leaking. Aluminum can be more durable, though acrylic cases are strong enough to handle the inevitable bashing against the rocks. Housings should connect to your camera's flash shoe and provide wiring to fire external strobes when required. Look for a housing that supports through-the-lens (TTL) metering for the external strobes.

- ***A super-wide angle lens (around 16-24mm)***. A zoom lens is useful, and high-end housings provide attachments to adjust the zoom. Wide-angle lenses are the right choice for most outings, especially when you're just beginning. Wide-angle lenses allow you to take scenic views underwater, but more importantly, they allow you to photograph fish just a few inches in front of your camera. You'll need to get that close to take clear pictures underwater.
- **A *diopter***. If the lens can't focus closer than 12", you will need a +4 diopter—a filter that screws on the front of the lens and allows you to focus closer. The diopter is required because light passes differently through water. You know how things look closer underwater? Cameras have the same issue. Focusing will work normally underwater with the diopter, but on land, you'll only be able to focus very close to the front of the lens. For that reason, and the fact that the underwater housing is cumbersome, it's a good idea to bring a second camera to take pictures above water.
- **Optionally, a *telephoto macro lens (around 100–150mm)***. If you want to take pictures of individual fish, you'll need a telephoto macro lens. It can be very difficult to align and focus a telephoto lens underwater, though, so it's a good idea to start with a super-wide angle lens.
- **A *lens port* that fits your lens (see the following figure)**. Housings ship with a big hole in the front, so you'll need to buy a lens port to cover your lens. The lens port must be slightly longer than your lens (with any diopters attached). Check the maximum diameter of the lens port and verify that your lens will fit through it. For wide-angle lenses, use a *dome port*—a port with a rounded end—along with a diopter filter. For macro lenses, use a *flat lens port*.

Tech details: Dome ports act as an additional optical element by shaping the water in front of your lens into an arc. This helps to reduce refraction, distortion, and aberrations caused by water. It also requires the lens to focus very closely, as if you were taking a picture of an image projected on the inside of the dome itself. That's why you need a macro lens or a diopter when using a dome port. Flat ports don't correct the problems that occur when light must pass through air, water, and then back through air again inside your housing. The distortion and aberration are unacceptable when using a wide-angle lens, but are mostly hidden when using a telephoto lens. That's why flat ports are limited to telephoto macro lenses.

- ***Underwater strobes***. Your existing flash won't work; you'll need underwater strobes if you're going any deeper than 40 or 50 feet. Preferably, two strobes, attached to the left and right sides of the housing. If you want to take video, be sure to choose strobes that act as hot lights—meaning they can give off light continuously. Be sure you have batteries or chargers for the strobes.
- **Extra o-rings and lube**. The water-tight seal is creating by an o-ring (a flexible piece of rubber that runs around the edge of the two halves of the housing). It's a good idea to keep an extra in case yours gets damaged.
- **Weights**. On land, your underwater housing might seem incredibly heavy. It's mostly air, though, and underwater, it might be too buoyant to easily dive with. You might, or might not, need to add lead weight to your underwater housing. The only way to find out is to try your gear out, but it wouldn't be a bad idea to bring extra weights with you so you can add them as required.

As you can imagine, all this gear is expensive. If you're using strobes, you'll spend more than $3,000, and you can easily spend $5,000. It's also heavy—you won't want to carry the gear around on land.

Chapter 12: Canon EOS/EF/EF-S DSLR Buying Guide

Canon EOS/EF is the largest and most popular camera system ever made (followed closely by the Nikon F-mount). When you enter the Canon world, you gain access to thousands of bodies, lenses, and flashes.

Canon has, in my opinion, the greatest lens selection of any camera manufacturer. However, their camera bodies have fallen behind other manufacturers, especially Nikon.

Most people choose a camera system when they find a camera body they like, and then they choose lenses that work with that body. For some photographers, however, it's smarter to choose a lens you need for your work, and then choose the best body to work with that lens. In the Canon world, there are a couple of lenses that the closest competitor, Nikon, simply doesn't offer a perfect alternative for at the same price point:

- **Canon 50mm f/1.8**. This cheaply made $100 lens isn't technically great at anything, but it's incredibly inexpensive and autofocuses with all Canon bodies. Photographers with budgets under $600 are routinely thrilled with the great background blur and low-light capabilities of this lens. The Nikon version (the 50mm f/1.8G) is better, but it costs more than twice as much. The Nikon 50mm f/1.8D doesn't autofocus with entry-level bodies.
- **Canon 70-200 f/2.8 L IS II**. This is the best lens in the world for professional portraiture. The Nikon variety has severe focusing problems that make it behave like a 130mm lens for close headshots, and an experienced photographer will definitely appreciate the extra length when working at close range with the Canon.
- **Canon 400mm f/5.6**. For wildlife, this lens is relatively inexpensive (around $1,000 used) and lighter and sharper than similarly priced zoom lenses. Getting similar results on a Nikon requires using the 300mm f/4 and a 1.4X teleconverter, which is a significantly more expensive setup.

But before buying your first Canon camera, take a serious look at the Nikon lineup. Nikon camera bodies at a similar price point generally produce technically better pictures, and Nikon has a much newer and fuller lineup of full-frame cameras for professionals. While the casual photographer will never notice the difference, I now recommend Nikon to all serious photographers who don't need a specific Canon lens.

In other words, if you're shooting landscapes and travel, you should seriously consider Nikon instead of Canon. If you're the type who shoots raw, recovers shadows, and is annoyed by noise in photos, you probably want a Nikon.

Canon DSLR Buying Guide

Video: Canon DSLR Comparison

53:12

sdp.io/CanonLineup

This table shows the Canon DSLRs currently available. In this table, FPS is Frames Per Second, the number of shots you can take in one second. IQ stands for Image Quality, and more stars is better. MP stands for Megapixels, which hardly makes a difference in the Canon lineup, because they're all pretty similar.

US Model	Europe Model	Price (new)	Price (used)	Artic. Display	Touch screen	Wi-Fi	GPS	Full-frame	MP	IQ	FPS
SL1	*100D*	*$600*	*$450*		*				*18*	*	*4*
T3	*1100D*	*$305*	*$250*						*12*	*	*3*
T5	1200D	$440							18	*	3
T3i	*600D*	*$500*	*$400*	*					*18*	*	*3.7*
T4i	650D	$690	$450	*	*				18	*	5
T5i	700D	$700	$600	*	*				18	*	5

60D			$550	*					18	**	5.3
7D		*$1,300*	*$600*						*18*	**	*8*
70D		*$1,200*	*$1,100*	*	*	*			*20*	**	*7*
5D Mark II			$1,200					*	21	***	4
6D		*$1,900*	*$1,550*			*	*	*	*20*	***	*4.5*
5D Mark III		*$3,100*	*$2,700*					*	*22*	***	*6*
1D X		$6,700	$5,000					*	18	****	14

The used prices provide a very rough estimate of what I consider to be a "good" used price. If you find a body in good condition for less, it's a bargain. If you find a body priced higher, it's not the best deal.

The stats reveal only a small part of the story. Here are the unique aspects of each camera, and why you might want to choose them.

Video: Canon Wildlife & Sports Comparison **40:53** *sdp.io/CSports*	

Video: Canon Video Comparison **26:55** *sdp.io/CVideo*	

Canon Rebel SL1/Canon 100D ($600 new, $450 used)

The *Canon SL1* is impossible to compare to the rest of the Canon lineup, because it's a very specialized body, optimized for size. It's tiny, offering mirrorless portability with the flexibility of a DSLR.

If you want the smallest Canon DSLR you can buy, the SL1 is the right choice for you. If you want the size benefits of mirrorless cameras with the Canon lens selection, buy the SL1. If carrying a few extra ounces and inches isn't a big deal, you should choose one of the other cameras.

Canon Rebel T3/Canon 1100D ($300 new, $250 used)

Canon's entry-level camera, the T3, is my standard recommendation for everyone's first camera. Even if you have a budget of thousands of dollars, I'd rather you spend more of your budget on lenses, flashes, tripods, and software.

The T3 gets the job done, but it does have a couple of weaknesses:

- Limited buttons require you to look at the screen to make common adjustments, such as adding exposure compensation. This can slow you down by a few seconds, but isn't a problem for most photographers.
- Video is limited to 720p, whereas all other Canon cameras record 1080p.
- The autofocusing system makes it frustrating to photograph moving subjects.

Canon Rebel T5/1200D ($500 as a kit, $450 used)

The newest version of Canon's entry-level camera is hardly changed from the previous-generation T3. The T5 has a couple of minor improvements:

- 1080p video (instead of 720p in the T3)
- A sharper LCD screen with 460,000 dots, instead of just 230,000

Image quality and focusing speed are essentially unchanged. If you find a good deal on a T5, it's a great camera. If you're shopping around and don't need 1080p video, you might be happier buying a used T3. If you do plan to do some video, a used T3i has 1080p video and adds an articulating screen.

Canon Rebel T3i/600D, T4i/650D, and T5i/700D ($500-700 new, $450-600 used)

One step up from entry-level, these cameras offer identical image quality and focusing to the T3. However, they do add some nice features:

- An articulating screen, which is useful for self-portraits, video, and shots at high or low angles.
- 1080p video recording

You might want to upgrade if you find it annoying to adjust exposure compensation, if you struggle with focusing on moving subjects, or if you want better image quality.

The only significant difference between the *T3i* and the *T4i*/*T5i* is that the later models add a touch screen. The image quality and focusing are essentially unchanged.

Before buying one of these Canon cameras, consider the Nikon D3200. While the new Nikons tend to have fewer features, they have substantially better image quality. For example, the image quality of the Nikon D3200 ($400) is about 25% better than the T5i/700D ($650), which is enough to make a visible difference in your photos. However, the D3200 lacks many of the T5i's important features, such as an articulating touchscreen.

60D ($550 used)

The 60D is no longer being manufactured, but it's a great deal used. The 60D is Canon's mid-range crop camera. Compared to the lower-end cameras, it offers these benefits:

- Better image quality, equivalent to the 7D and 70D.
- A thumb-dial on the back that allows you to quickly adjust your exposure.

70D ($1,200 new, $500-$1,000 used)

Video: 70D Comparison	

34:46 sdp.io/70DReview	

The 70D has almost identical strengths to the Canon 7D, though the frames per second is a bit slower (7 fps instead of 8 fps) and the buffer fills up a bit sooner than does the 7D. Because the 70D is technically considered a lower-end camera than the 7D (despite being overall more powerful and expensive), the 70D is smaller and lighter than the 7D, which most consider to be an advantage.

Here are the reasons to choose the 70D:

- Autofocus while recording video. This is the only Canon camera that can track moving subjects in video. If you want a video camera for general use, the 70D is the right choice for you.
- Compared to the lower-end cameras (excluding the 7D), it offers amazing autofocus and high frames per second.
- Compared to the 7D, it offers an articulating touch screen and Wi-Fi, making it a better camera for general use.

Currently, the 70D is Canon's top-end body with a crop sensor. Before buying the 70D, you should seriously consider either a used 5D Mark II or a 6D. For just a few hundred dollars more, those bodies offer significantly better image quality and background blur. However, they are bigger and heavier, have weaker autofocus systems, and lack the articulating touchscreen.

Before buying a 70D, consider a Nikon D7000, which can be bought used for about $600. The D7000 offers about 15% better overall image quality, which is a substantial gain. However, the D7000 isn't as good for action shots, because the buffer fills quickly, and it lacks the 70D's Wi-Fi and video focusing capabilities.

7D ($1,300 new, $600 used)

Though technically the 7D is still available new, it has been (mostly) replaced by the much newer 70D. If you want a 7D, you should definitely buy a used body because of the steep discount. Most people interested in spending $1,300 on a new body should buy the 70D instead.

A used 7D is an amazing value, however, and they often sell for as low as $550. Its amazing autofocus system has 9 cross-type autofocus points that do an amazing job at tracking moving subjects. In fact, the autofocus system is only exceeded by the much more expensive 5D Mark III and 1D X.

Because the 1.6X crop factor brings you closer to distant sports and wildlife, a used 7D is my recommendation for most outdoor sports and wildlife photographers, regardless of their budget. When I'm shooting distant subjects in good light, I choose the 7D even over a 5D Mark III or 1D X. The 7D's 18 megapixels are all crammed into the center of the frame, providing far more detail than any of Canon's full-frame cameras can provide.

Though image quality is no better than the 60D, compared to the lower-end cameras, the 7D offers these benefits:

- Autofocus capable of tracking moving subjects using any focus point.

- Higher frames per second, for capturing action.
- Improved durability and weather sealing.

The 7D is the right camera for well-lit action. If you plan to do portraiture or landscape, you should choose either save your cash for lenses and buy a used 60D, or make the jump to full-frame image quality with a used 5D Mark II or a new 6D.

Note that the 7D lacks the articulating screen of the lower-end cameras. This improves durability, but I do often miss the articulating screen. The 70D offers most of the capabilities of the 7D with an articulating touchscreen.

If this is your first camera, you should also consider the Canon 70D and the 7D. The 70D has fantastic autofocus capabilities during video, and the 7D can be had used for $500-$750 (and it doesn't have the D7000's focusing issue). All these cameras have excellent autofocus systems, but the D7000 does have more focusing points (though that will probably never impact your photography) and much better image quality (which will impact your photography).

Before buying a 7D, consider a Nikon D7000, which can be had for about the same price used. The D7000 offers about 17% better overall image quality, which is a substantial gain. However, the D7000 isn't as good for action shots, because the buffer fills quickly.

7D Mark II ($1,800 new)

Video: 7D Mark II Preview

34:20

http://sdp.io/7D2Preview

The 7D Mark II is Canon's ultimate sports and wildlife camera, and for many, it's the greatest action camera in the world.

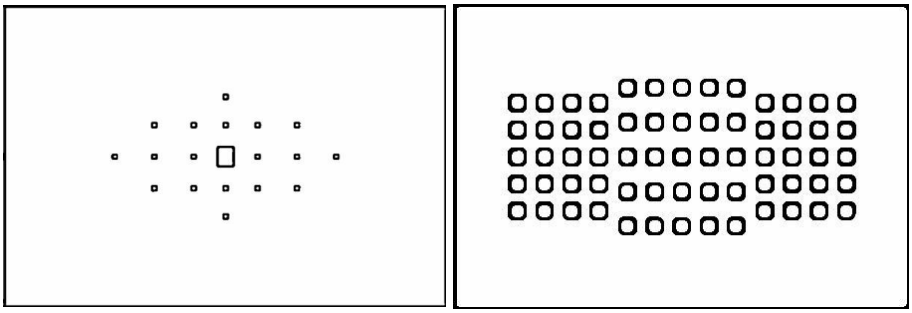
Standing at the top of Canon's APS-C/EF-S lineup, the 7D Mark II has a remarkable autofocus system matched only by the $6,800 1DX. The autofocus points almost fill the entire frame, and each point is an extremely capable cross-type sensor. In short, the 7D Mark II is better than almost any camera at tracking moving subjects.

For most sports and wildlife photographers, the 7D Mark II is a better choice than the higher-end 5D Mark III, primarily because of the smaller sensor. In situations where you can't get close enough to your subject and you have to crop by 1.6X anyway, the 5D Mark III would be reduced to only 14 megapixels, while the 7D Mark II still has the full 20 megapixels. Of course, if you can get close enough to fill the frame on your lens with a 5D Mark III, the image quality will certainly be better. However, with wildlife, animals rarely get close enough to allow you to fill the frame, even with massive telephoto lenses, so the extra pixel density does result in sharper pictures.

If you plan to shoot sports and wildlife but the 7D Mark II is out of your price range, the original 7D is still an excellent alternative. It doesn't take pictures quite as fast, the buffer is smaller, and the autofocus system is inferior, but a used 7D costs about 1/3 the price of a new 7D Mark II, and they take similar images.

The following figures compare the autofocus points of the original 7D to the new 7D Mark II. As you can see, the 7D Mark II spreads the autofocus points further around the frame. For action where you don't have the opportunity to use the focus-

recompose technique, this provides for more flexible compositions.



For video, the 70D is a better choice, because the 70D has an articulating touchscreen. This allows you to see live view easier from different angles. You can also take advantage of the video autofocus capabilities better by simply touching the screen on the 70D. With the 7D, you need to use the joystick to select an autofocus point in order to refocus, and this is going to shake the camera unacceptably during video. If video is your primary purpose, you might also consider the Panasonic GH4.

The articulating touch screen and lower price also make the 70D a better choice for general photography, other than sports and wildlife. For landscape and portrait photography, I recommend one of the Canon full-frame cameras, such as the Canon 6D, which is about the same price as the 7D Mark II. For landscapes, you might also look into the Nikon DSLR lineup, because their sensors create sharper images with less noise and greater dynamic range.

5D Mark II ($1,200 used)

A used *5D Mark II* is the best value for Canon shooters interested primarily in still image quality. While the autofocus system is less-than-ideal, the 5D Mark II offers the same image quality as the much more expensive 6D and 5D Mark III. Used, it's about the same price as a Canon 70D, but the image quality *far* exceeds that of the 70D or any crop camera.

For that reason, and because a used 5D Mark II is about the same price as a 70D, I recommend the 5D Mark II to photographers primarily interested in portraits or landscapes.

The 5D Mark II's autofocus system is similar to the 6D, though the 6D's center autofocus point does better in very low-light conditions. The 7D and the 70D have far better autofocus systems for moving subjects, making them better choices for sports and wildlife.

Video: 5D Mark II vs 5D Mark III

11:46

http://sdp.io/5D2v5D3

6D ($1,900 new, $1,550 used)

The *6D* is Canon's entry-level full-frame camera. It provides vastly better image quality than any of the crop cameras. Here are the reasons you should upgrade to a 6D from the previous cameras:

- The full-frame sensor provides 60% better background blur than a crop camera can, improving portraits.
- The full-frame sensor provides MUCH better image quality, especially in low-light, making it ideal for landscapes and indoor photography. For this reason, I recommend it for indoor sports, despite having a weaker focusing system than the 7D or 70D.
- It has a GPS, which no other Canon camera has. It also has Wi-Fi, which the 70D also has.

Despite the fact that it's 50% more expensive than the 70D, the 6D lacks several key features of the 70D:

- All of the 70D's focus points are cross-type, making it a better choice for sports and wildlife. With the 6D, you will need to use the center autofocus point for moving subjects, limiting your composition choices.
- The 70D does an excellent job of focusing on moving subjects while recording video. The 6D (and all other Canon cameras) do an awful job.
- The 70D has an articulating screen, which reduces durability, but is helpful for shooting self-portraits or at strange angles.
- The 70D has a touch-screen, which the 6D does not.

Also, all lower-end cameras feature a pop-up flash. This is hardly a benefit, however, because pop-up flashes are awful. Additionally, the low-light image quality of the 6D and all Canon full-frame cameras provides better results in situations where you might want a pop-up flash.

The 6D replaced the 5D Mark II, and used prices are within 20% of each other. The 6D is a better camera than the 5D Mark II in almost every way, but these are the key benefits. Use them to determine whether it's worth the extra cash to upgrade over a 5D Mark II:

- Wi-Fi allows you to browse files from your phone or tablet. This is useful for proofing photos in a studio, or for posting a picture to Facebook from your smartphone.
- GPS can record your location, which is very useful when traveling.
- The live view display works far better than the 5D Mark II's in low-light environments, making it much easier to compose and focus night photos.
- The mode dial has a locking button, preventing you from accidentally changing modes—a problem that always plagued the 5D Mark II.
- The center autofocus point works well in much lower light conditions than the 5D Mark II can handle.

Before buying the 6D, consider buying a used Nikon D600 ($1,300) or a new Nikon D610 ($2,000). The Nikon bodies offer about 12% better overall image quality, which is a significant advantage. However, they lack the 6D's built-in GPS and Wi-Fi.

5D Mark III ($3,100 new, $2,700 used)

Video: 5D Mark III Long-term Review **12:55** *sdp.io/5D3Long*	

The primary difference between the *5D Mark III* and the 5D Mark II or 6D is the amazing autofocus system, which covers a large part of the frame and tracks moving subjects with amazing accuracy, surpassing even the 7D and 70D.

For that reason, the 5D Mark III is the right choice for sports and wedding photographers, whether serious amateur or professional. Those tasks require tracking moving subjects, often in low-light conditions, and the 5D Mark III will give you more in-focus pictures than any lower-end camera.

However, the 5D Mark has the exact same image quality as the 6D and 5D Mark II, which are far less expensive. Therefore, if you're not tracking fast-moving subjects, choose one of those two bodies, and save the rest of your cash for lenses and flashes.

The 5D Mark III isn't the best choice for most wildlife photographers. Instead, I recommend purchasing a used 7D, and saving the rest of your budget for lenses. The 5D Mark III is excellent for wildlife photography when you can get very close, so if you plan to be spending hours camouflaged in a blind, the 5D Mark III might be a better choice for you. The 5D Mark III supports autofocus up to f/8, allowing you to attach a teleconverter to a lens such as the 400mm f/5.6 and still autofocus. However, you can only use the center autofocus point, which limits composition.

You should also consider the 36-megapixel Nikon D800. The D800 has 15% better image quality, making it a better choice for landscape and commercial photographers. It's a better choice for most wildlife photographers, too, because the DX crop mode provides a 1.5X teleconverter effect while still capturing 24 megapixel images; more detail than even the 7D.

Video: D810 vs 5D Mark III **25:33** *sdp.io/d810v5d3*	

Canon 1DX ($6,800 new, $5,500 used)

The 1-series Canons (currently the *1D X*) are intended for professionals who really abuse their camera bodies and don't mind carrying around the extra weight. With those cameras, you're paying thousands of dollars for durability, weather sealing, and longevity that very few people will need. Therefore, I almost never recommend them to people who ask which camera to buy. They're wonderful cameras, but if you need them, you probably already know, and wouldn't be seeking advice from me.

The 1D X offers even stronger autofocusing than the 5D Mark III, and all autofocus points work up to f/8, allowing you to use a teleconverter with telephoto lenses. The amazing 14 frames per second greatly increases your chances of capturing the action at the perfect moment.

Image quality is also noticeably better than the lower-end full-frame cameras, despite having a lower megapixel count.

Which Portrait Lens and Flash Should I Buy?

Which lens you should buy depends on your budget. In order from least to most expensive (and least to most preferred):

- $100 (EF or EF-S): *Canon 50mm f/1.8*
- $420 (EF or EF-S): *Canon 85mm f/1.8*
- $770 (EF or EF-S): *Tamron 70-200 f/2.8*
- $1000 (EF-S only): *Sigma 50-150 f/2.8*
- $1,500 (EF or EF-S): *Tamron 70-200 f/2.8 OS*
- $2,500 (EF or EF-S): *Canon 70-200mm L IS II*

A flash is important even for casual portraiture. You never want to use the built-in flash, because it's very unattractive. Instead, buy an external flash, which doesn't have to be expensive. I recommend two different flashes:

- **$100**: *Yongnuo YN-468 II*. This flash is powerful enough for most situations, and features TTL (through-the-lens) metering. It lacks high-speed sync (HSS), which can be important when shooting portraits outdoors on a sunny day. Even if you decide need a more powerful flash later, you can always use this as an off-camera flash, because it has an optical slave built in.
- **$200**: *Yongnuo YN-568EX II*. This flash is as powerful as any flash available, and supports both TTL and HSS.
- **$570:** *Canon 600EX-RT*. In addition to the features supported by the YN-568EX, the top-end Canon flash adds support for an external battery pack (useful primarily for weddings and other big events) and radio frequency (RF)-based remote control.

Notice that I don't recommend most of the Canon flashes. The Canon flashes are generally overpriced and all except the top-end 600EX-RT have a very outdated infrared (IR) remote control system. For more information, refer to the *Flash Buying Guide*.

What Speedlight/Flash Lighting Equipment Should I Buy?

If you want to go beyond natural light, or a single on-camera flash, you can add multiple, remote flashes or strobes to create the exact lighting you want. Based on your budget, my recommendations for portable studio lighting are:

- **$250**: Three *Neewer TT560 flashes*, a *Yongnuo RF-603 remote trigger*, *a light stand kit with umbrellas* ($60), *an extra light stand* ($20), and a *flash snoot* ($13). The remote trigger will only control one flash; setup the other two flashes as optical slaves.
- **$700:** Three *Yongnuo YN-568 flashes* ($190 each), a *Yongnuo RF-603 remote trigger* ($30), *two softbox umbrellas ($33)*, *three light stands* ($20 each), and a *flash snoot* ($13). The remote trigger will only control one flash; setup the other two flashes as optical slaves. This setup provides slightly nicer light than the less expensive setup, and the flashes support HSS, which will allow you to shoot in bright daylight.
- **$1,300:** Two Phottix Mitros+ flashes ($400 each), a *Yongnuo YN-568 flash* ($190), a Phottix Odin transmitter ($200) *a light stand kit with umbrellas* ($60), *two softbox umbrellas ($33)*, *three light stands* ($20 each), and a *flash snoot* ($13). The upgraded remote trigger set will give you control over the output of two of the Phottix flashes, allowing you to increase or decrease the light without leaving your camera. The Yongnuo flash will act as an optical slave, but since it'll probably be a hair light or a kicker light, you don't need to frequently adjust the output.

If you're dedicating a room in your house to be a studio, you should buy monolights that plug into the wall. The lights recycle faster than flashes, and you never have to worry about replacing the batteries. I recommend the *AlienBees* system; choose whichever equipment is appropriate for your needs.

For more information about exactly what you might want in your studio, refer to *Chapter 9, "Studio Lighting Buying Guide."* For information on how to use the gear, refer to Chapter 6 of Stunning Digital Photography.

Canon Flash Recommendations

The following table summarizes flash options for Canon cameras. For the zoom column, the table describes the maximum coverage range, including the coverage provided by a diffuser that you might need to manually flip down. My recommended flashes are highlighted in the table. Because manufacturers often exaggerate their flashes' guide numbers, I provided GN test results performed by third parties whenever possible.

Note that I recommend the Yongnuo YN-565EX flash despite reviews reporting early failure. As of May 2012, Yongnuo redesigned the flash to improve the reliability. While it's difficult to assess the reliability of the flash without waiting several years, early reviews indicate that the problems are solved, and you could buy 3.5 YN-565EXs for the price of one 600EX-RT.

Flash	Price	GN (ISO 100, 35mm)	TTL	Bounce	Zoom	HSS	Manual controls	Optical slave	Battery pack
Neewer TT560	$40	20m/66ft (tested)		Tilt & rotate			X	X	X
Yongnuo YN-560 II	$70	34m/113ft (tested)		Tilt & rotate	18 to 105mm		X	X	X
Yongnuo YN-468 II	*$87*	*20m/66ft (tested)*	*X*	*Tilt & rotate*	*18 to 85mm*		*X*	*X*	
Yongnuo YN-565EX	*$150*	*36m/116ft (tested)*	*X*	*Tilt & rotate*	*18 to 105mm*		*X*	*X*	*X*
Yongnuo YN-568EX II	*$187*	*36m/116ft (tested)*	*X*	*Tilt & rotate*	*18 to 105mm*	*X*	*X*	*X*	
Sigma EF-610 DG ST	$135	19m/62ft (tested)	X	Tilt & rotate	17 to 105mm		X		
Sigma EF-610 Super	$225	19m/62ft (tested)	X	Tilt & rotate	17 to 105mm	X	X		

Canon 90EX	$150	9m/30ft	X						
Canon 270EX II	$155	22m/72ft	X	Tilt	28mm or 50mm	X			
Canon 320 EX	$225	28m/92ft (tested)	X	Tilt & rotate	24mm or 50mm	X			
Canon 430 EX II	$255	34m/112ft (tested)	X	Tilt & rotate	14 to105mm	X	X		
Phottix Mitros	*$300*	*58m/190ft (exaggerated)*	*X*	*Tilt & rotate*	*14mm to 105mm*	*X*	*X*	*X*	*X*
Canon 600EX-RT	$550	39m/128 ft (tested)	X	Tilt & rotate	14mm to 200mm	X	X		X

The newest Canon flash, the 600EX-RT can be controlled wirelessly using radio signals. These work great—even better than PocketWizards. However, no other flash supports the feature. Therefore, if you want to control multiple remote flashes using the new radio system, you need to buy multiple 600EX-RTs at $550 each. If you want to remotely control each flashes power output, you can buy an additional flash to put on your camera, or you can buy the *Canon ST-RT-E3 Speedlight Transmitter ($287)*.

That's expensive, but not too much more expensive than buying a *Phottix Odin set ($400 for two flashes)* and *Phottix Mitros flashes ($300 each)*. A three-light setup with the 600EX-RTs would cost you $1,937, whereas the Phottix setup would cost you $1,437. The Phottix setup seems like a bargain for $500 less, but it requires you to attach separate receivers to each flash, which is more to carry, more to keep fresh batteries in, and more that could go wrong.

Here are my specific recommendations for different types of Canon photographers:

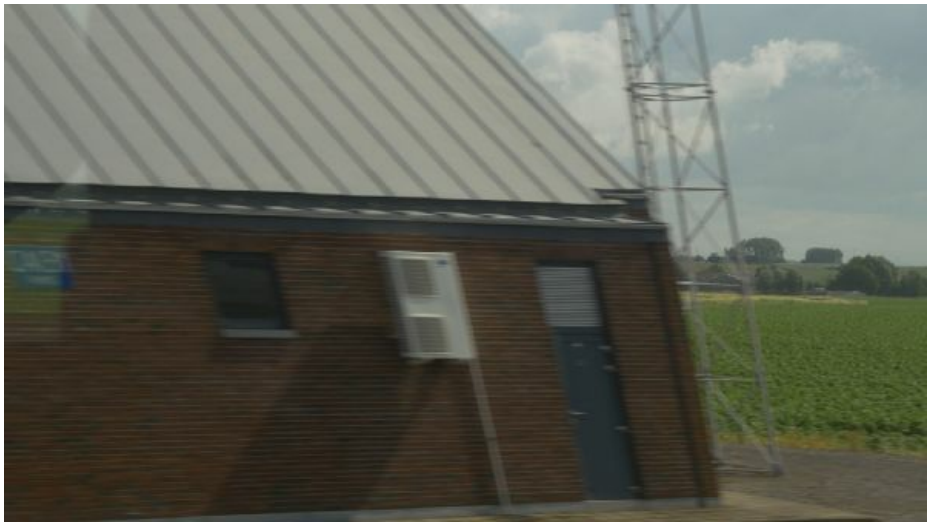
- **General candid family pictures**: *Yongnuo YN-468 II ($100)*
- **Weddings and events**: *Yongnuo YN-568EX II ($190)* and a set of *Eneloop AA batteries* or the *Canon 600EX-RT* with an external battery pack (professional)
- **Posed portraits with on-camera flash**: *Yongnuo YN-565EX ($123)*
- **Sports**: *Yongnuo YN-568EX II* and a set of *Eneloop AA batteries*
- **Real estate**: *Yongnuo YN-565EX ($123)*
- **Off-camera flash (for use with multi-light setups)**: *Yongnuo YN-560 II ($60)* with *Yongnuo RF-603* (manual) or *Yongnuo YN-568EX II* with *Yongnuo YN-622C* (professional)

Blackmagic Design

Blackmagic Design makes several video cameras that use the Canon EOS lens mount. This book is focused on still cameras, but the Blackmagic cameras are worth mentioning because the success of the Canon and Blackmagic video cameras has led third parties to introduce a wide variety of fast, manual focus prime lenses.

Blackmagic Design cameras have several key differences. First, the video quality tends to be sharper than DSLRs. Second, the dynamic range is far greater. If you know how to grade your videos, the raw video from a Blackmagic camera will allow you to show details in a bright sky and in the shadowy foreground. With other cameras, the sky would need to be overexposed.

Another key difference between this proper video camera and a DSLR is that it has a global shutter. The global shutter eliminates rolling shutter, a problem with DSLRs that causes moving subjects to appear to lean to the side, as shown in the following still from a Panasonic GH4 video taken on a train. Obviously, the building and tower are vertical, but the all DSLRs and mirrorless cameras will render them as shown. The Blackmagic design cameras, however, render them vertical. This only matters if you're shooting action and you're serious about it; most viewers won't even notice rolling shutter.



There are numerous other differences that make the video workflow more efficient. In a nutshell, it's designed as a video camera rather than a stills camera, making it better at video.

Blackmagic Cinema Camera ($2,000 new, $1,750 used)

The Blackmagic Cinema Camera is a bigger version of the MFT-only Pocket Cinema Camera, offering higher resolution 2.5k video and a larger form factor. As with the Pocket Cinema Camera, this camera is capable of recording raw video with incredible dynamic range, creating better-quality videos. However, this is overkill for most casual videographers.

This camera has an outrageous 2.39X crop factor, meaning a 50mm f/1.4 lens behaves like a significantly less sharp 120mm f/3.3 lens. It records to an internal Solid State Drive (SSD), which is a type of fast and expensive hard disk. The SSD is much quicker to offload large amounts of video than a memory card, just one of the many ways that Blackmagic Design supports professional video workflow better than a DSLR.

This exact camera is also available with an MFT mount if you prefer to use MFT lenses. The MFT version of the camera lacks autofocus and image stabilization, however.

Blackmagic Production Camera 4k ($2,500 new)

Though the design is almost identical, the Production Camera 4k is a big upgrade over the Cinema Camera. The sensor is bigger, with a 1.7X crop compared to a 2.39X crop. Perhaps more importantly, it is also capable of recording 4k video with the same amazing quality and dynamic range.

Blackmagic URSA ($6,000 new)

The Blackmagic Design URSA is an ENG (Electronic News Gathering) style video camera. Video quality and crop factor are similar to the Production Camera 4k, but the URSA is larger and less dependent on building a separate rig because of the handle and multiple displays.

The URSA has many interesting features, but one of the most interesting is the user-replaceable sensor. In the future, Blackmagic could release a new sensor module and you could bolt it in, preserving your large investment in this camcorder.

Chapter 13: Nikon DSLR Buying Guide

This chapter provides an overview of Nikon DSLRs, follow by recommendations for Nikon and third-party flashes and portrait equipment.

Nikon has the strongest lineup of camera bodies in the world, and one of the best lens and flash lineups. I routinely recommend Nikon equipment for everyone from beginners on a sub-$500 budget to professional wildlife photographers with over $10,000 to spend.

Elsewhere in this book, I've done my best to help with the difficult decision every DSLR buyer faces: Canon or Nikon. While I have found a handful of distinct benefits of the Canon infrastructure, in most ways, Nikon meets or exceeds the standard set by the #1 camera manufacturer. You almost can't go wrong by buying a Nikon.

If you're considering buying your first Nikon camera, there are a couple of scenarios where you might want to consider a different manufacturer:

- **Video**. If great video is more important to you than great still photos, you should consider Panasonic instead. Specifically, examine the GH2, GH3, and GH4 cameras (whichever new or used model fits your budget). They offer more video features, such as focus peaking and smarter focusing during recording. The newest cameras also offer 4k recording, which Nikon does not currently offer. Panasonic cameras are simply smaller, less expensive, and more capable than Nikon for most video work.
- **Wildlife**. If your budget is under $5,000, I would steer you to Canon instead. Lower-end Canon cameras tend to focus faster and have larger buffers, which are important factors for wildlife. Also, Nikon has no direct equivalent of the amazing Canon 400mm f/5.6 prime. Specifically, I recommend buying a used Canon 7D and a used 400mm f/5.6, for $1,500-$2,000 total. Of course, many amazing wildlife photographers use Nikon gear, but for most, Canon currently offers better bang-for-the-buck.
- **Portraiture**. I suggest casual portrait photographers buy a used Canon T3 and 50mm f/1.8 for about $400 total; that setup provides autofocus and great background blur at a price point Nikon can't currently match. For more serious portrait and wedding photographers with budgets over $5,000, the Canon 70-200 f/2.8 simply can't be matched because the Nikon equivalent of that lens has serious focus breathing problems that impact close-range portraiture. Intermediate portrait photographers with budgets from $1,000 to $5,000 could go with Canon or Nikon and see very similar results.

Nikon DSLR Buying Guide

This table shows the Nikon DSLRs currently available. In this table, FPS is Frames Per Second, the number of shots you can take in one second. IQ stands for Image Quality, and more stars is better. MP stands for Megapixels, which hardly makes a difference in the Canon lineup, because they're all pretty similar. Motor refers to whether the body has a built-in focusing motor, allowing it to work with older lenses that lack a built-in focusing motor.

Model	Price (new)	Price (used)	Arctic. Display	Wi-Fi	GPS	Full-frame	MP	FPS	Motor
D3100	$350	$200					14	3	No
D3200	$380	$350					24	4	No
D3300	$600 (kit)	$500					24	5	No
D5100	$470	$300	*				16	4	No
D5200	$620	$550	*				24	5	No
D5300	$750	$620	*	*	*		24	5	No
D90	$614	$300					12	4.5	Yes
D7000	$900	$600					16	6	Yes
D7100	$1,150	$900					24	6	Yes
D300S	$1,450	$700					12	7	Yes
D600	$1,450	$1,250				*	24	5.5	Yes
D610	$1,900	$1,500				*	24	6	Yes
D750	$2,300		Tilt	*		*	24	6.5	Yes

D800	$2,800	$2,200				*	36	4-6	Yes
D810	$3,300					*	36	5-7	Yes
Df	$2750	$2,100				*	16	5.5	Yes
D3X		$2,800				*	24	5	Yes
D4		$3,600				*	16	10	Yes
D4S	$6,500	$5,500				*	16	11	Yes

If you're investing in your first Nikon camera, I suggest taking your total budget, dividing it by two, and picking the Nikon camera that you can afford. Then, set aside the rest of your budget for lenses, flashes, a memory card, and a tripod.

Most photographers should choose one of the less expensive Nikon DX APS-C cameras (such as the D3x00, D5x00, D7x00). If you must make massive prints, or you need a full-frame FX lens for your style of photography, upgrade to one of the FX bodies (D6x0, D7x0, D8x0, or Df).

The single-digit Nikons (currently the D3X and D4) are intended for professionals who really abuse their camera bodies and don't mind carrying around the extra weight. With those cameras, you're paying thousands of dollars for durability, weather sealing, and longevity that very few people will need. Therefore, I almost never recommend them to people who ask which camera to buy. They're wonderful cameras, but if you need them, you probably already know, and wouldn't be seeking advice from me.

For that reason, the D810 is the highest-end camera that I recommend for amateurs and most pros. If you have an unlimited budget, get the D810 and several lenses. Otherwise, get the kit highlighted in the table that best suits your budget.

Within the professional bodies, the D3X and D4/D4S are very similar in price. The D3X is more of a general purpose professional camera body, while the D4 is specialized for low light, sports, and photojournalism.

Here are the unique aspects of each camera, and why you might want to choose them.

Nikon D3100/D3200/D3300 ($350-$400 new, $200-$350 used)

Video: D3300 Review

30:19

sdp.io/d3300Review

Nikon's entry-level DSLRs are perfect for beginners; saving money on the body lets you spend more on lenses, flashes, tripods, memory cards, and software, and those will have a bigger impact on your photography than buying a more expensive body.

The *D3100* is available for outrageously low prices used; my target price is $200, but you can find them even cheaper if you're patient. If you're buying new, the *D3200* is a better value. It has slightly better image quality and it takes pictures a bit faster. However, the D3200 creates much larger photos, which also make it much slower to copy and edit your photos.

The D3200 also adds a mic jack for recording external audio with your video. If you plan to record video and don't want to use the built-in mic (which is awful on all cameras), the mic jack is a must. The D3200 also jumps to 24 megapixels (the

D3100 has 14 megapixels) providing much larger pictures. Those larger pictures require larger memory cards and more disk space, but only have slightly better image quality. The higher 4 frames per second (from 3 fps on the D3100) will help with action shots, but the buffer fills up too quickly for this to be a great sports camera.

The D3300 is about 9% smaller and lighter than the D3200 and D3100. Additionally, its updated AF-S 18-55mm kit lens is about 25% smaller and lighter than the kit lens included with the D3200 and D3100.

For the D3300, Nikon continued using the 24 megapixel sensor, but removed the optical low-pass filter. This means that your pictures will be a bit sharper and more detailed, but you'll probably never notice the difference unless you use professional-quality lenses costing far more than the body itself. The D3300 also jumps to 5 frames per second, making it more useful for sports and action.

If this is your first camera, you might also consider the Canon T3/1100D. The cameras are equally functional; I'd buy whichever I found a better price on.

Nikon D5100/D5200/D5300 ($470-800 new, $300+ used)

Video: D5300 Overview 39:18 sdp.io/d5300overview	

The D5100 and D5200 offer similar image quality to the D3100 and D3200 (respectively). Here, your extra money goes towards a very useful articulating screen. If you're taking a self-portrait, flip it out so you can make sure you're not cutting off your own head. It also allows you to hold the camera low to the ground or over your head while still seeing the screen.

The D5200 and D5300 provide a big megapixel increase over the D5100—jumping from 16 megapixels to 24 megapixels, and that megapixel increase does improve overall image quality.

The D5300 ($800 new, $600-$700 used) is the first camera in the Nikon lineup to offer Wi-Fi and GPS. The Wi-Fi is fun but will probably never help you take a better quality picture. The GPS is very useful for those who travel with their camera, because it helps you find your pictures by browsing them on a map (if you use Lightroom or another app that organizes photos by GPS data). For landscape or wildlife photographers, the GPS data can help you find your way back to a spot, so you can shoot the same location at a different time of year.

If this is your first camera, you might also consider the Canon T3i/600D, T4i/650D, or T5i/700D. Those three Canon models take very similar pictures, and I would simply choose whichever model I found the best deal on.

Video: D3300 vs D5300 13:08 sdp.io/d3300vsd5300	

Nikon D90 ($600 new, $300 used)

Since it's one of the older cameras discussed here (it was released mid-2008), the *D90* looks terrible on paper: 13 megapixels, 4.5 frames per second, and 720p video recording. However, it's a sturdy, capable camera that has one particularly compelling feature: a built-in focusing motor.

This built-in focusing motor allows you to use older Nikon "AF" lenses that lack a built-in focusing motor. These lenses rely on a mechanical coupling with the camera body to drive the lens focus.

You certainly don't *need* a focusing motor. You can simply choose from the wide variety of AF-S lenses that have built-in focusing motors. However, if you're the type who's always looking for used specialty lenses at amazing prices, such as older wildlife lenses, you'll get better lenses at lower prices if you can choose from those older AF lenses.

For that reason, the D90 is my recommendation for the eBay-savvy bargain-hunter. Everyone else should choose one of the newer Nikon bodies, however.

Nikon D7000 ($900 new, $600 used)

The *Nikon D7000* is an excellent camera for wildlife and sports photographers, with a fast 6 frames per second continuous shooting rate, a 16 megapixel DX sensor that gives you a 1.5x crop when using telephoto lenses, and a 39-point autofocus system.

There's one big, big weakness for those shooting action: a small buffer. It will work fine if you're shooting JPG, storing about 100 consecutive shots without slowing down. However, if you shoot raw (as most serious photographers will) you'll be limited to 10 or 11 consecutive frames before the camera slows down.

That means that you'll get less than two seconds of continuous shooting. That's not enough for your kid to make the run from third base to home, and it will be incredibly frustrating when shooting flying birds, which typically take 4-5 seconds in a single run.

If this is your first camera, you should also consider the Canon 70D and the 7D. The 70D has fantastic autofocus capabilities during video, and the 7D can be had used for $500-$750 (and it doesn't have the D7000's focusing issue). All these cameras have excellent autofocus systems, but the D7000 does have more focusing points (though that will probably never impact your photography) and much better image quality (which will impact your photography).

Nikon D7100 ($1,150 new, $900 used)

The D7100 would be an even better camera for wildlife photography than its predecessor, the D7000. However, the D7100's increase in megapixels from 16 to 24 further decreases the number of consecutive raw photos you can capture. At 6 frames per second, you can shoot for only one second before the camera slows down to one frame per second... and that's simply not long enough to adequately capture a bird in flight.

However, the combination of 24 megapixels and a 1.5x crop factor make the D7100 the most detailed wildlife camera available, though the requirement to shoot in raw definitely limits your image quality and your ability to recover blown out highlights (a common requirement for wildlife photographers).

If money is no object, consider upgrading to the $2800 D800, which has an amazing 36 megapixels and provides similar levels of detail in DX mode, which crops the full-frame sensor just like a D7100 (but without the buffer issue). If that's outside your budget, consider a used Canon 7D ($500-$1000).

Nikon D300S ($1,450 new, $700 used)

Released mid-2009, I would never recommend buying a new *D300s*. However, at around $700, a used D300S is an excellent option for a beginner camera and for wildlife photographers on a budget. It's only 12 megapixels, and Nikon's sensor was a bit dated even when the D300S was released. More importantly for wildlife photographers, it supports a stunning 7 frames per second (for up to 17 continuous raw frames) and 51-point autofocus.

If you're a wildlife photographer not already invested in Nikon lenses, also consider a used Canon 7D, which costs about the same. The 7D has 50% more megapixels and can record 1080p video, instead of the D300S' 720p video. The 7D can also shoot at a slightly faster 8 frames per second, capturing 14-bit RAW files instead of the 12-bit RAW files that the D300S is limited to at higher speeds. Perhaps most importantly, you can use the incredible Canon 400mm f/5.6 with the Canon 7D. However, the 51 autofocus points of the D300S make it easier to track flying birds than the 7D, and the D300S has dual memory card slots.

Nikon D600/D610 ($1,800/$2,000 new, $1,300 used)

Nikon's low-end full-frame cameras, the 24 megapixel *D600* and D610, are the answer for most photographers who can't tolerate the noisy low-light images of the DX bodies. The larger sensor captures more light, allowing you to get cleaner images when shooting indoors or in the evenings. Both the D600 and D610 are great, well-rounded bodies.

While all the FX full-frame cameras offer substantially better image quality than the DX cameras, and 60% shallower depth-of-field (useful for portrait work), there are a couple of disadvantages:

- You'll need full-frame FX lenses to take advantage of the larger sensor, and these tend to be more expensive.
- Both the camera body and lenses are heavier (though few people complain).

In the studio, a DX camera can be passable for portrait work. Out of the studio, the D600 and D610 are ideal portrait cameras, allowing you to get full-frame background blur from your portrait lens with smooth, low-noise skin tones, even when working indoors or in the shade.

The D600 and D610 also make good choices for those who want to shoot indoor sports like volleyball, basketball, or hockey. While the focusing system isn't as robust as many of the other cameras, and the frames per second isn't as fast, the full frame sensor provides much cleaner images than any of the DX cameras, and these bodies are significantly less expensive than the higher-end bodies.

The D600 has become rather infamous for developing oil spots on the digital sensor. While photographers complain at length about minor problems with every camera body ever released, the oil spots on the D600 are a serious problem that shouldn't be underestimated. According to polls on the Internet, most D600 users have serious problems with oil spots that create visible spots on pictures. Unfortunately, I don't have a more reputable source than polls on the Internet, but I have spoken with several long-time D600 users who experienced the problem.

Fortunately, you can remove the oil spots by cleaning the sensor, as described in Chapter 5 of Stunning Digital Photography. Users also report that the oil spots go away after about 3,000 frames have been shot. Because of the bad reputation but fairly easy mitigation of the oil spot issue, a used D600 might be a particularly good bargain. Unfortunately, there's no hard data to allow me to guarantee that you won't see oil spots.

The introduction of the D610 in the fall of 2013 offered very little more than freeing Nikon from the D600's bad reputation. The sensor, processor, and autofocus systems are exactly the same as the D600. The D610 did add a quiet shutter mode (which is useful) and a 10% increase in frames per second from 5.5 to 6.

If you plan on shooting wildlife, you should choose a DX camera instead, such as a D7000 or a used D300S. If you want the ultimate in image quality and an upgraded focusing system, check out the D800.

If you're not yet invested in the Nikon system, you should compare the D600 and D610 to the full-frame Canon 6D. The Canon camera can't quite match the Nikon's image quality, but it adds a GPS feature that I really enjoy and a somewhat useful Wi-Fi feature.

Nikon D750 ($2,300 new)

Video: D750 Preview 20:00 sdp.io/d750preview	

Fitting between the D610 and D810, the D750 combines the superior autofocus system from the D810 and D4S with the lower resolution 24 megapixel sensor of the D610.

If you plan to take any sports or wildlife shots, it's a worthy upgrade from the D610. However, if you're a travel and landscape photographer, the D610 can save you $500 that might be better spent on lenses.

As the middle child in the Nikon FX lineup, the D750 is mostly made from parts of other cameras, but there is one very unique and important feature: a tilt screen. While dozens of cameras have a similar tilt screen, the D750 is the only full-frame camera to have one. They're immensely useful for creative composition, including shooting still subjects slow to the ground or when holding your camera over your head (for example, when shooting in crowds). However, the live view autofocusing is rather slow, so don't expect to chase wildlife or football players using the tilt screen.

If you plan to buy sharp, high quality lenses, upgrading to the D810 can provide you with more detailed images. However, if you choose to use the fairly unsharp 24-120mm f/4 kit lens, the D750 gives about as much detail as you'll be able to get.

Nikon D800 and D800E ($2,800/$3,000 new, $2,200 used)

The Nikon *D800* and D800E are incredible cameras, with better image quality than any other DSLR ever made—and that includes medium format cameras. The 36 megapixel full-frame sensor is simply incredible, making these models the ultimate choice for anyone primarily concerned with capturing detail.

In all other aspects, the D800 is a very capable camera, with 51-point autofocus (15 cross-type sensors), solid build quality, and good video capabilities. Off-the-shelf, the D800 is only 4 frames per second, making it a bit slow for wildlife and sports. If you enable DX crop mode (which crops the image 1.5X to a 24 megapixel image taken from the center of the frame), you get 5 frames per second. However, the option MB-D12 vertical battery grip speeds it up to 6 frames per second in DX crop mode.

The D800E is the same camera as the D800, but has the anti-aliasing (AA) filter removed. The AA filter simply blurs detail a tiny amount, helping to remove artifacts that can appear in fine details. However, it also removes a small amount of detail. Therefore, pictures from the standard D800 tend to look a little nicer to the eye, whereas the D800E technically captures more detail. This picture explains it much better than words can.

The standard D800 is the better choice for most users. If you're a commercial photographer who closely post-processes all their images and requires medium format levels of detail, choose the D800E.

If you zoom in tight on images from the D800, the images seem to be quite noisy compared to other full-frame cameras, even at ISO 100. The D800's high megapixel count means that each individual pixel captures less light, increasing noise. However, once you resize images to the same resolution as every other camera, the noise seems to disappear. In a nutshell, the D800 is noisier than the D600 and Canon's full-frame cameras, but in use, the D800's image quality is always superior.

The high megapixel count does cause some headaches, however. Having 50% more pixels than most full-frame cameras means that images take 50% longer to load, and your computer will need to work 50% harder when processing them. You'll also need 50% more storage space both in your camera and on your computer. If you're not using the sharpest lenses available, you won't even be able to take advantage of the detail, so be prepared to spend extra money on glass. Basically, the D800's huge images are a pain, and unless you enjoy or really need the detail, it's probably not worth it.

While I regularly recommend DX cameras for wildlife because they show more detail in distant subjects, the D800 offers a crop mode that gives you the best of both worlds. By cropping just the center of the massive 36 megapixel sensor, the D800's crop mode produces 24 megapixel images with a 1.5x crop, turning a 400mm lens into a 600mm lens while also providing a wide field of view that makes it easier to locate and track moving animals. For wildlife photographers with big budgets, the D800 is the ultimate body.

For most portrait photographers, the D600 is a better choice; save the extra $1,000 for lenses and lighting. However, wedding photographers will appreciate the D800's more powerful autofocus system.

Before buying the D800, check out the Canon 5D Mark III. The D800 has about 15% better image quality than the 5D Mark III, but the Canon's lower megapixel count increases the frames per second to 6, which is 50% faster when shooting full-frame images. The smaller images are also quicker to load and process. The Canon also offers faster autofocus, which will be important for sports and weddings.

Nikon D810 ($3,300 new)

Video: D810 Preview 33:00 sdp.io/d810preview	

The D810 is, in my humble opinion, the greatest still photo camera ever made (as of August 2014). Sure, there are medium format cameras with bigger sensors and more pixels, and Nikon's own D4S is twice the price. I'd rather have the D810.

The image quality is the best in the world, it has one of the best focusing systems ever made, it's smaller than a D4S or a medium format camera, and you can connect hundreds of Nikon-compatible lenses to it. If you can afford it, this is the camera for you.

Still, it's not the camera that I would recommend to most people. You can get similar image quality from a used D800E (this camera's predecessor), and that's the right choice for everyone who doesn't need the D810's greatly improved focusing system. Most portrait photographers should buy a D610 and save the extra money for lenses and lighting; you won't miss the extra megapixels. Some hard-core professionals will need specific features of the D4S, such as the weatherproofing or the gigabit Ethernet.

But for wedding, wildlife, and sports photographers, or anyone who has the budget, the D810 is the greatest camera ever made.

Video: D810 vs 5D Mark III 25:33 sdp.io/d810v5d3	

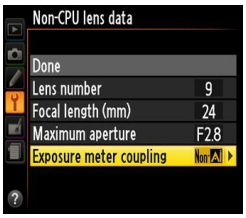
Nikon Df ($2,750 new)

Here's a camera that doesn't fit in with any other DSLR made by Nikon or any other camera manufacturer—the Nikon Df. It's available in either silver or black. I wouldn't normally bother mentioning the finishes a camera body is available in, but the Df is all about style and fashion.

While most DSLRs have a "form follows function" design, the Df uses a "form over function" philosophy. It's a beautiful, retro camera modeled closely after the Nikon F3 from 1980; a year that many of us were young camera nerds, wishing we could play with the buttons and dials on our parents' or grandparents' cameras.

The buttons and dials on the Df are indeed cool. Instead of relying on pressing a button and spinning a dial to select your ISO, exposure compensation, shutter speed, and aperture, the Df provides dedicated dials resembling the mechanical dials of the early 1980's DSLRs. The dials aren't faster or more convenient than those found on other modern DSLRs; quite the opposite. However, they are infinitely cooler to use.

Functionally, there's only one other important nod to the past: an inclusion of a metering coupling lever that allows you to connect pre-Ai Nikon lenses made from 1959 to 1977. Basically, Ai lenses with an aperture ring have this little gear (the metering coupling lever) on the body mount that meshes with a matching gear on the body, and tells the camera what aperture you've dialed in. The camera uses this information to help with metering. Unfortunately, the metering coupling lever can cause some lenses designed before Nikon developed Ai to jam. On the Df (but not on any other DSLR), you can move this lever out of the way to connect these older lenses, or move it back in place for compatibility with Ai lenses.



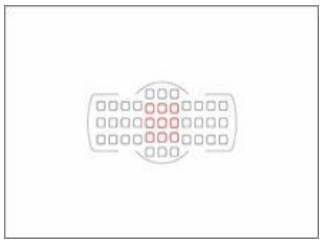
The Df's firmware also provides the ability to configure pre-Ai lenses. Basically, you'll setup your pre-Ai lens in the firmware, flip the metering coupling lever out of the way, and then attach your lens. If you decide you want to use auto exposure, you can meter your scene with the camera, and then transfer the camera's aperture recommendation from the LCD display to the aperture ring on the lens. It's much like using an external meter.

sc All Nikon bodies offer some level of compatibility with older lenses, however, n older lens; just those pre-Ai lenses.

There's also a PC Sync connection for connecting to older flashes, but that's still a fairly common feature on other modern DSLRs. It also supports a screw-in style remote cable release, which will definitely feel retro when your friend with the 6D is using his iPhone to trigger his camera. Of course, it has a focusing motor built into the body, like most of the higher-end Nikon cameras, so you can use lenses without autofocus motors.

A word of caution, however, from a photographer who spends almost as much time using old manual film cameras as modern DSLRs: using old lenses isn't going to be as much fun as you think. Yes, you can buy a used, manual Nikon 50mm f/1.4 Ai with a real aperture ring on it for under $100 (compared to $440 for the new equivalent). Attach it to your Df, and you can have a real, manual experience with plenty of mechanical dials to turn. However, the lack of split-prism or ground glass focusing screen in the Df makes manual focusing much more difficult than it was with the original F3. Further, older lenses simply weren't nearly as sharp as modern lenses, even when they're in perfect condition.

The Df includes most of the modern features you've come to expect: wonderful, low-noise image quality from the D4's 16-megapixel sensor, a 3.2 inch LCD screen, a modern autofocus with 39 autofocus points (9 cross-type, as shown in the following image), ISO 25,600 (expandable to 204,800), and even electronic dials if you decide not to use the mechanical-style dials on top of the camera.



Before buying it, however, you should be aware that it lacks several important modern features:

- **Video**. Seriously, it doesn't record video. It's an oddly selective nod towards retro-minimalism for a camera that includes so many other modern features, including live view and cheesy post-processing effects.
- **Ergonomics**. Consumer cameras from the 80s had smaller grips, as does the Df. The smaller grip slightly reduces the weight of the camera, but it also significantly reduces the comfort when using the camera. The dials were optimized for style, rather than usability, and you won't be adjusting those stylish dials without taking your eye from the viewfinder. However, their use is entirely optional, because the Df provides redundant digital controls. The shutter button is on top of the camera, rather than on the grip, where your index finger lands more naturally.
- **GPS and Wi-Fi**. Like most of the Nikon lineup, it lacks these niceties. Like many other modern Nikon bodies, you can connect the WU-1a wireless adapter ($46) or the GP-1/GP-1A ($300).

The Df is the most fun DSLR on the market today. If you're bored of your existing DSLR, it's a great choice. However, if you have $3,000 and want to make stunning images as efficiently as possible, choose a D800 instead.

Nikon D3X ($2,800 used)

The 24 megapixel *D3x* is Nikon's previous-generation professional camera (introduced near the end of 2008), designed for people who need their cameras to suffer substantial abuse and keep working. While all the Nikon cameras can handle a bit of rain, the D3x is designed to be used by photojournalists catching splashes from a fire hose, or paparazzi standing in a thunderstorm capturing Kanye and Kim fighting in the street. I tell every photographer to ditch the camera bag and expose their cameras to a little abuse, but the D3x loves the abuse, and is designed to handle being dropped over and over across its lifetime.

Because the D3x is designed to be so durable, used models hold up well. However, used models were probably owned by professionals, so they might show signs of wear from using the camera as it was intended.

Before buying the D3x, carefully consider a D800. The D800 feels flimsy compared to the D3X, it captures 20% fewer frames per second, and the autofocus system simply doesn't compare. However, the D800 has a 50% better megapixel count and about 7% better image quality. The D800 is significantly less expensive, too. In fact, if you don't need a bullet-proof professional-grade camera, the D800 is overall a superior camera to the D3X, and you'll have money left over for lenses and lights.

Nikon D4 ($3,500 used)

If it costs the most, it must be the best, right? Not necessarily. The *D4* is Nikon's previous-generation professional-grade camera, and it originally cost $6,000. My target price for a used copy is now $3,500; allowing you to buy the top-end model for the price of the mid-range D810.

As with the D3x (the predecessor), the D4 is designed to be abused. If you're going to abuse your camera, you need the D4 or D4S. If you need to shoot 11 frames per second for 9 seconds, you need the D4. If you might make thousands of dollars by getting an action shot in focus, you need the D4. Otherwise, you're better off with one of the less expensive Nikons.

Surprisingly, the D4's image quality is almost identical to the D3x. Therefore, if you do need a professional camera but don't need the higher frames per second, you should consider buying a used D3x for about half the price.

Nikon D4S ($6,500 new, $5,500 used)

Video: D4S Preview 12:31 sdp.io/d4sPreview	

The D4S is Nikon's 2014 update to the professional-grade D4. It's a definite step up from the D4, with a very small jump in price, making it an excellent value for someone looking for a camera of this caliber. The most important improvements are:

- 11 frames per second with continuous autofocus. The D4 didn't allow continuous autofocus at the highest frame rate.
- Group AF, which causes multiple focus points to work together and can make tracking some types of moving subjects easier.
- Shorter blackout periods when shooting at a high frame rate, making it easier to track moving subjects through the viewfinder.
- 60 frames per second 1080p video, up from 30 frames per second.
- Gigabit Ethernet, allowing for faster tethering in a studio environment.

If none of these improvements are important to you, you might consider a used D4 instead. The image quality will be similar, but you can find a used D4 for less than $4,000.

The 16 megapixel sensor seems to pale in comparison to the D810's 36 megapixel sensor, despite being more than twice as expensive. Indeed, the D810 does extract far more sharpness and detail out of professional lenses. The D810 also has better dynamic range, though the D4s has slightly less noise. The smaller files of the D4s are easier to manage, and make the high frame rates possible.

Nikon Flash Recommendations

The following table summarizes flash options for Nikon cameras. For the zoom column, the table describes the maximum coverage range, including the coverage provided by a diffuser that you might need to manually flip down. My recommended flashes are highlighted in the table. Because manufacturers often exaggerate their flashes' guide numbers, I provided GN test results performed by third parties whenever possible.

Note that I recommend the Yongnuo YN-565EX flash despite reviews reporting early failure. As of May 2012, Yongnuo redesigned the flash to improve the reliability. While it's difficult to assess the reliability of the flash without waiting several years, early reviews indicate that the problems are solved. Even if they're not, you could buy 3 YN-565EXs for the price of one SB-910.

Flash	Price	GN (ISO 100,	TTL	Bounce	Zoom	High-	Manual	Optical	Battery

		35mm)				speed sync	controls	slave	pack
Neewer TT560	$45	20m/66ft (tested)		Tilt & rotate			X	X	X
Yongnuo YN-560 II	$70	34m/113ft (tested)		Tilt & rotate	18 to 105mm		X	X	X
Yongnuo YN-468 II	*$100*	*20m/66ft (tested)*	*X*	*Tilt & rotate*	*18 to 85mm*		*X*	*X*	
Yongnuo YN-565EX	*$150*	*36m/116ft (tested)*	*X*	*Tilt & rotate*	*18 to 105mm*		*X*	*X*	*X*
Yongnuo YN-568EX	*$200*	*36m/116ft (tested)*	*X*	*Tilt & rotate*	*18 to 105mm*	*X*	*X*	*X*	
Sigma EF-610 DG ST	$135	19m/62ft (tested)	X	Tilt & rotate	17 to 105mm		X		
Sigma EF-610 Super	$225	19m/62ft (tested)	X	Tilt & rotate	17 to 105mm	X	X		
Nikon SB-400	$120	21m/69ft	X	Tilt					
Nikon SB-N5	$140	8.5m/28ft	X	Tilt & rotate		X			
Nikon SB-N7	$160	18m/59ft	X	Tilt		X			
Phottix Mitros	*$300*	*58m/190ft (exaggerated)*	*X*	*Tilt & rotate*	*14mm to 105mm*	*X*	*X*	*X*	*X*
Nikon SB-700	$330	29m/94ft (tested)	X	Tilt & rotate	24 to 120mm	X	X		
Nikon SB-910	$550	29m/95ft (tested)	X	Tilt & rotate	12 to 200mm	X	X		X

Here are my specific recommendations for different types of Nikon photographers:

- **General candid family pictures**: *Yongnuo YN-468 II*.
- **Weddings and events**: *Yongnuo YN-568EX* and a set of *Eneloop AA batteries* (amateur) or the *Nikon SB-910*.
- **Posed portraits with on-camera flash**: *Yongnuo YN-565EX ($150)*.
- **Sports**: *Yongnuo YN-568EX* and a set of *Eneloop AA batteries*.
- **Real estate**: *Yongnuo YN-565EX ($150)*.
- **Off-camera flash (for use with multi-light setups)**: *Yongnuo YN-560 II* with *Yongnuo RF-603* (manual) or *Phottix Mitros ($300 each)* with *Phottix Odin* (automatic)

Which Portrait Lens and Flash Should I Buy?

Which lens you should buy depends on your budget. In order from least to most expensive (and least to most preferred):

- $200 (DX or FX): *Nikon 50mm f/1.8G AF-S FX*
- $500 (DX or FX): *Nikon 85mm f/1.8G AF-S*
- $770 (DX or FX): *Tamron 70-200 f/2.8*
- $1,000 (DX only): *Sigma 50-150 f/2.8*
- $1,500 (DX or FX): *Tamron 70-200 f/2.8 VC*

- $2,400 (DX or FX): *Nikon 70-200 f/2.8 ED VR II*

A flash is important even for casual portraiture. You never want to use the built-in flash, because it's very unattractive. Instead, buy an external flash, which doesn't have to be expensive. I recommend two different flashes:

- **$100**: *Yongnuo YN-468 II*. This flash is powerful enough for most situations, and features TTL (through-the-lens) metering. It lacks high-speed sync (HSS), which can be important when shooting portraits outdoors on a sunny day. Even if you decide you need a more powerful flash later, you can always use this as an off-camera flash, because it has an optical slave built in.

- **$200**: *Yongnuo YN-568EX*. This flash is as powerful as any flash available, and supports both TTL and HSS. The only important feature it lacks that the much more expensive *Nikon SB-910* has is support for an external battery pack, which allows you to take pictures faster and for a longer period of time.

Notice that neither of my recommendations are Nikon flashes. Don't let that deter you; the Nikon flashes are overpriced. They feature a system that will allow wireless remote control, but it doesn't work that well. For more information, refer to the *Flash Buying Guide*.

What Speedlight/Flash Lighting Equipment Should I Buy?

If you want to go beyond natural light, or a single on-camera flash, you can add multiple, remote flashes or strobes to create the exact lighting you want. Based on your budget, my recommendations for portable studio lighting are:

- **$250**: Three *Neewer TT560 flashes*, a *Yongnuo RF-603 remote trigger* ($30), *a light stand kit with umbrellas* ($60), *an extra light stand* ($20), and a *flash snoot* ($13). The remote trigger will only control one flash; setup the other two flashes as optical slaves.

- **$700:** Three *Yongnuo YN-568 flashes* ($190 each), a *Yongnuo RF-603 remote trigger* ($30), *two softbox umbrellas ($33)*, *three light stands* ($20 each), and a *flash snoot* ($13). The remote trigger will only control one flash; setup the other two flashes as optical slaves. This setup provides slightly nicer light than the less expensive setup, and the flashes support HSS, which will allow you to shoot in bright daylight.

- **$1,300:** Two Phottix Mitros+ flashes ($400 each), a *Yongnuo YN-568 flash* ($190), a Phottix Odin transmitter ($200) *a light stand kit with umbrellas* ($60), *two softbox umbrellas ($33)*, *three light stands* ($20 each), and a *flash snoot* ($13). The upgraded remote trigger set will give you control over the output of two of the Phottix flashes, allowing you to increase or decrease the light without leaving your camera. The Yongnuo flash will act as an optical slave, but since it'll probably be a hair light or a kicker light, you don't need to frequently adjust the output.

If you're dedicating a room in your house to be a studio, you should buy monolights that plug into the wall. The lights recycle faster than flashes, and you never have to worry about replacing the batteries. I recommend the *AlienBees* system; choose whichever equipment is appropriate for your needs.

For more information about exactly what you might want in your studio, refer to *Chapter 9, "Studio Lighting Buying Guide."*

Don't buy continuous lighting; that's for video, and it isn't bright enough to get great image quality for portraits. For information on how to use the gear, refer to Chapter 6 of Stunning Digital Photography.

Chapter 14: Sony DSLR/TSLR Buying Guide

This table shows the Sony DSLRs currently available. They all have a 1.5X crop factor.

Model	Price (new)	Price (used)	Megapixels	Full-frame	IBIS	GPS	Wi-Fi NFC	Frames per second
a3000	$400 with lens	$250	20		*			3.5
a58	$420		20		*			5
a65	$600	$500	24		*	*		10
a77	$900	$700	24		*	*		12
a77 II	$1,200				*		*	12
a99	$2,800	$2,000	24	*	*	*		10

Choosing a Sony body is simple—the more you spend, the more you get. Sony doesn't have nearly the options or variety of Canon or Nikon, and they haven't been around long enough for there to be high-value previous-generation used recommendations for me to suggest.

As discussed earlier in this chapter, Sony SLT cameras are very different from the Canon and Nikon DSLRs. Some of those differences are advantages, while others are distinct disadvantages. It's up to you to determine whether the advantages outweigh the disadvantages:

- SLT technology provides much better video focusing capabilities.
- The SLT allows a higher frames per second, and you can see through the viewfinder while taking pictures.
- The SLT allows quieter shooting.
- The electronic viewfinder (EVF) allows you to review pictures and the histogram without taking your eye away from the viewfinder.
- Sony tends to introduce new technologies earlier than other manufacturers.
- The EVF introduces a slight amount of latency, so what you see through the viewfinder actually happened a fraction of a second in the past. That's fine for general shooting, but it makes tracking sports and action very difficult.
- The SLT reduces the light reaching the sensor when taking a picture, requiring you to use 1/3 higher ISO, increasing noise in the image.
- Sony has a much smaller lineup of lenses and flashes, though there is enough variety for casual photographers.
- Sony's lenses tend to be less sharp than similarly priced Canon and Nikon equivalents.
- Tamron, Sigma, and other third-party lens manufacturers have started to offer lenses for Sony SLT cameras, but there are far fewer options.
- Similarly, third-party flash and wireless flash trigger manufacturers mostly ignore Sony, limiting your options for off-camera lighting. You'll need an adapter to use studio flash triggers.

Sony a3000 ($420 new)

Sony's entry-level a3000 camera offers 20 megapixel image quality with a 1.5X crop factor and 3.5 frames per second, similar

to Canon and Nikon's entry-level cameras. Its user interface is based on the NEX range of cameras, making it less complex than most DSLRs, and therefore more beginner-focused.

The biggest difference between the a3000 and the Canon and Nikon DSLRs is the autofocus during live view and video recording. Thanks to the Sony SLT design, the camera can use phase-detect focusing without moving the mirror in front of the sensor. If you're looking for an entry-level camera with DSLR capabilities that will double as a capable handicam, this is the best choice. However, the a3000 lacks a headphone jack, so you can't monitor the sound its recording.

Sony a58 ($420 new)

A small step up from the a3000, the *a58* adds a tilting LCD screen, allowing you to see it more easily while holding it over your head or low to the ground. The 5 frames per second is slower than the rest of the Sony lineup, but faster than the Nikon and Canon equivalents.

Like other Sony cameras, the 1080p video capabilities are excellent. Like the a3000, the a58 lacks a headphone jack, so you can't monitor the sound its recording.

Also like other Sony cameras, it includes plenty of gadgets and tricks. Those are fun, but I have one request: please don't ever use the auto-crop feature. I'm happy to let cameras autofocus and auto-expose, but we can't let them auto-compose. Instead, study Chapter 2 of Stunning Digital Photography.

Before buying the a58, you might consider buying a used a57 for about the same price as a new a58. The a57 is very similar to the a58, but it offers a full 10 frames per second.

Sony a65 ($600 new, $500 used)

The 24 megapixel *a65* is a significant step up from the a58, offering twice the frames per second (10 fps). It also offers an articulating screen, though the screen is oddly attached to the bottom of the camera instead of the left side of the camera, as most other cameras. That makes it rather difficult to use the articulating screen to help you frame a self-portrait while the camera is on a tripod or resting on a table.

Sony a77 ($900 new, $700 used)

One small step up from the a65, the *a77* offers an incredible 12 frames per second. Getting 12 frames per second requires spending about $6,000 on a Canon or Nikon body. The a77 also supports 1080p video recording at 60 frames per second, allowing you to create smooth, slow motion video (at half normal speed). Most DSLRs record video at 1080p and 30 frames per second, which is standard for HD television and movies.

Compared to the a65, the a77 also offers improved autofocus, helping you keep moving subjects in focus. Overall, it's a better camera for action than the a65.

Sony a77 II ($1,200 new)

The second generation a77 is a minor improvement on the original (which remains a great value). It adds more focusing points, jumping from 19 to 79 total. 15 of those 79 focusing points are the more accurate and faster cross-type focusing points—the original a77 only had 11 cross-type focusing points. Additionally, the a77 II focuses in half the light, down to -2EV from -1EV. That just means you'll find it easier to autofocus during night photography.

The original a77 would fill its buffer after just 17 JPG shots—just one-and-a-half second of shooting. The a77 II can capture 60 JPGs before filling the buffer, making the new generation much better for shooting action.

For use with third-party flashes and studio lights, the a77 II has a conventional hot shoe instead of the Sony-proprietary hot shoe.

Sony a99 ($2,800 new, $2,000 used)

Sony's top-end camera is designed to compete with the Canon 5D Mark III and Nikon D800. It certainly does compete with its

more famous peers, though in many ways, it plays a completely different game.

It offers 10 frames per second, about double what the Canon and Nikon cameras offer at this price point. It's also the only full-frame camera to offer an articulating display, and of course, the SLT design allows for continuous autofocus in live view and while recording video. Canon and Nikon simply can't match those features with a traditional DSLR design. The a99's image quality is about 10% better than the 5D Mark IIIs and only 5% off the D800s.

However, if you're considering spending almost $3,000 on a body, you're clearly a very serious photographer, and you need to think carefully about whether the Sony system is the one you want to be involved in. For more information about potential drawbacks with the Sony system, refer to the beginning of this section.

If sports or other action shots are important to you, consider the 5D Mark III as an alternative. The 5D Mark III has a much stronger focusing system.

If wildlife is your top priority, consider the Nikon D800, which offers a DX crop mode that gives you 24 megapixels with a 1.5x crop, extending the reach of your telephoto lenses by 50%. Also consider a Canon 7D, Nikon D7000, or Sony a77, because they each offer more detail in the center of the image, effectively cropping your picture before you take it.

Chapter 15: Pentax DSLR Buying Guide

This chapter provides an overview of Pentax APS-C and medium format DSLRs.

Pentax APS-C DSLRs

Pentax offers a variety of APS-C cameras, competing with the entry-level to mid-range offerings from Canon, Nikon, and Sony. In comparison to the more popular competitors, the Pentax cameras offer better weather-sealing, a reputation for durability, and in-body image stabilization (IBIS) which Pentax calls Shake Reduction (SR).

It's this last feature, SR, which is the most practical benefit of the Pentax cameras. With SR, any lens is image stabilized—even prime lenses, such as the 50mm f/1.8. Fast primes with image stabilization provide unbeatable low-light hand-holding capabilities.

If you're interested in IBIS but want an electronic viewfinder and a wider variety of lenses, look into the Olympus mirrorless camera lineup. However, the smaller sensor of the Olympus Micro Four-thirds cameras, along with the higher Olympus base ISO (200) produces noisier images.

Before choosing the Pentax system, be sure that you're happy with the Pentax DA and DA* variety of lenses. Canon and Nikon each offer a much wider variety of lenses, but Pentax offers more than enough lenses for most photographers, and they're all optimized for APS-C. Additionally, my favorite APS-C lens, the Pentax 18-35mm f/1.8, is available for the Pentax format, and that might be the only lens you need.

While you can use the Pentax FA lenses, they were designed for film cameras, and as a result they won't be quite as fast or sharp as the more modern lenses.

Unfortunately, all Pentax cameras lack modern niceties that are becoming common in other cameras of this price range, including touch screens, Wi-Fi, NFC, and GPS. The autofocus capabilities don't match those of similarly priced cameras from Canon and Nikon, either.

In short, most photographers looking into an APS-C DSLR should seriously consider Canon or Nikon cameras, instead. Choose Pentax only if:

- You plan to hand-hold the camera with fast prime lenses in low light (thus taking advantage of the IBIS).
- You really need the improved weather sealing.
- You want to take pictures rapidly of still subjects (thus taking advantage of the higher frame rates, but acknowledging the slower autofocus performance).
- You plan to be deeply immersed in countries where electricity might not be available, but from where you can purchase AA batteries (thus taking advantage of the fact that Pentax cameras can use standard batteries).
- You want a camera in wild color combinations.

The sections that follow provide an overview of the Pentax DSLR lineup.

Model	Price (new)	Price (used)	Megapixels	Max shutter	Frames per second
K-500 (kit)	$550	$400	16	1/6000	6
K-50 (kit)	$520	$480	16	1/6000	6
K-5II	$690	$550	16	1/8000	7
K-5IIs	$690	$620	16	1/8000	7
K-S1	$800		20	1/6000	5.4
K-3	$950	$920	24	1/8000	8.3

K-500 ($550)

The K-500 is Pentax's entry-level body. Compared to similarly-priced Canon and Nikon competitors, the faster shutter speed and higher frame rate should make it better for action. However, Pentax cameras have a bad reputation for tracking action in low-light, so if you need a sports camera for indoor basketball, volleyball, or other sports, you might instead look for a used Canon 7D or Nikon D5200.

It's hard to recommend the K-500 over the K-50. Pentax prices the K-500 at $600, compared to $780 for the K-50. However, at the moment, the K-50 is actually less expensive at most online stores. Therefore, I recommend upgrading to the K-500 instead to take advantage of the improved weather proofing and electronic level.

K-50 ($520 new for the kit)

One step up from the base model, the K-50 is a great value for the price. Compared to the Canon T5 or Nikon D3200 (similar models at this price point) the K-50 offers weather sealing and in-body image stabilization. If you plan to use fast prime lenses, this makes the K-50 a better choice for hand-holding pictures in low light environments.

The K-50 is available in a variety of colors. In fact, you can custom order your K-50 in 120 different color combinations. Buy one to match every outfit!

K-5 II ($680 new)

The K-5 II is Pentax's mid-range body, and though it's a couple of years old, it's still a capable APS-C camera at a great price. The 16 megapixel sensor won't yield as much detail as the 24 megapixel APS-C sensors from Nikon and Sony, but you'll never notice the difference with the kit lens, anyway.

Unlike the similarly-priced competitors from Canon, Nikon, and Sony, the K-5 II and K-5 IIs are weather-sealed.

If you're considering the K-5 II, I'd recommend choosing the K-5 IIs instead. The price is the same, and you'll get sharper images.

K-5IIs ($680 new)

The K-5IIs is identical to the K-5 II in every way except that Pentax has removed the anti-aliasing (AA) filter, allowing sharper images. In 2012 when the cameras were released, a camera without an AA filter was an important distinction. However, most cameras released in the past year have had the AA filter permanently removed.

Given that the K-5 IIs is available for the same price as the standard K-5 II, I recommend choosing this camera over the K-5 II. You'll get sharper images with almost no drawbacks.

K-S1 ($800 new)

The K-S1 is a small, cool, and capable APS-C DSLR. Pentax is appealing to the fashion-conscious photographer with a wide range of camera colors, as shown in the following image. It's a welcome relief from the standard black DSLRs.

If you like the small size of the K-S1 but want access to a wider variety of lenses, check out the Canon SL-1, which is a bit smaller but not as colorful.

K-3 ($950 new)

The K-3 is Pentax's top-of-the-line APS-C camera. For its price, the incredibly fast 8.3 frames per second simply can't be beat.

Another interesting feature is the selectable anti-aliasing filter. The AA filter is a feature of many digital cameras that reduces the sharpness of the image. That sounds like a bad thing, and it usually is. However, the AA filter also reduces some artifacts, such as moiré. The K-3 is the only camera that allows you to turn the AA filter on or off. However, most people should simply choose to leave it off, and I've never missed having an AA filter on my cameras that lack it.

Like many Pentax cameras, the K-3 is weather sealed, which won't matter to most people. All cameras can handle a certain amount of weather. If you know that you might get caught in a serious downpour but not be able to put your camera in your bag (for example, if you're doing photojournalism or professional sports) than the weatherproofing is meaningful.

The K-3 has 25 cross-type autofocus points, making it the best camera in the Pentax lineup for action. However, it still doesn't autofocus as well as similarly priced competitors from Canon and Nikon, such as the Canon 70D or Nikon D7100.

Pentax Medium Format 645Z ($8,600)

Video: Pentax 645Z Preview

14:39

sdp.io/645ZPreview

The 645Z is Pentax's medium format camera, supporting lenses from the company's long history of 4x5 medium format film cameras. However, the 645Z's digital sensor isn't as large as their film cameras. It's still quite a bit larger than full-frame 35mm digital cameras, with a 0.79X crop factor.

The Sony-made 51 megapixel sensor is clearly the star of this heavy, expensive body. If you absolutely must have more pixels than a Nikon D810, the Pentax 645Z is your only option under $10,000.

Medium format cameras offer a certain prestige because of their history in commercial photography, but even if you have the

budget, I'd still recommend the D810 over the 645Z to most photographers. Nikon offers a much wider variety of lenses than Pentax, and those lenses are less expensive than the Pentax equivalents. The larger size of the 645Z (especially with a few lenses) significantly hampers usability in all but commercial studio scenarios.

If you want to understand the potential benefits, read the Sensor Size And Crop Factor section of Chapter 3. Let's explore a few examples from the Pentax lens lineup:

- The Pentax-D 55mm f/2.8 ($1,200) is equivalent to a full-frame 43.5mm f/2.2. Therefore, despite the larger sensor, Pentax's normal prime is slower than the full-frame 50mm f/1.4 standard (about $400) and offers less background blur.
- The Pentax 28-45mm f/4.5 ($5,000) is equivalent to a full-frame 22-35mm f/3.5. Again, despite the larger size, it gathers less light and offers less background blur than a full-frame Tamron 24-70 f/2.8 ($1,100) lens.
- The Pentax 80-160mm f/4.5 ($2,100) is equivalent to a full-frame 63-126mm /f3.5. In the full-frame world, a 70-200 f/2.8 offers a wider zoom range and gathers more total light.

Because the lenses aren't particularly fast, the 645Z can't fulfill the promises of larger sensors: gathering more light and providing shallower depth-of-field. However, the higher megapixel count can allow extracting more detail given proper technique.

Another consideration is whether you can achieve cleaner images with lower noise in ideal conditions, such as tripod-mounted landscapes or studio photography. The 645Z's minimum ISO of 100 means that it can gather more total light than a full-frame 35mm camera at ISO 100; about two-thirds more light, in fact. That should translate to two-thirds cleaner images from the 645Z than a full-frame 35mm camera at ISO 100.

However, the Nikon D810 supports an unusually low ISO of 64, which gathers almost exactly the same total amount of light as the 645Z will at ISO 100. Though we haven't yet completing formal testing, we expect the D810 and 645Z to have similar noise levels in ideal conditions.

Obviously, anyone considering the 645Z should seriously consider the Nikon D810 instead. However, those with a total budget over $15,000, no concern about camera size or weight, and an obsession with capturing as much detail as possible should evaluate the 645Z.

If you're truly obsessed with detail and low noise, you might also consider the Mamiya 645DF Credo 80 ($38,000), which offers 80 megapixels and ISOs as low as 35. With a bigger sensor than the 645Z (it has a crop factor of about 0.62) and lower minimum ISO, the Mamiya can gather about two stops more light than the 645Z, or about three stops more light than a full-frame camera at ISO 100.

Chapter 16: Micro Four-Thirds (Panasonic/Olympus) Buying Guide

Micro Four-Thirds (MFT) is a standard that allows cameras and lenses from different manufacturers to work together. For example, with MFT, you can use an Olympus lens on a Panasonic camera, or vice-versa. This is quite remarkable considering that every other camera manufacturer, including Canon, Nikon, Sony, Pentax, Samsung, Fuji, and Leica, created a proprietary system that prevents you from using equipment from other manufacturers.

MFT uses a relatively small sensor—about ¼ the size of a full-frame DSLR, with roughly a 2x crop factor. That sensor is still much larger than the sensor I most camera phones and point-and-shoot cameras.

If you have the right lenses, smaller sensors are theoretically capable of taking similar quality images to larger sensors. Fortunately, the MFT system has an amazing variety of lenses. To get the best image quality from your MFT camera, I highly recommend using fast prime lenses and a body that supports In-Body Image Stabilization (IBIS), especially:

- Panasonic 20mm f/1.7
- Panasonic 20mm f/1.4
- Olympus 45mm f/1.8
- Olympus 75mm f/1.8

In addition to Olympus and Panasonic, BlackMagic Design also supports MFT lenses on their Pocket Cinema Camera, an appropriately named small, professional video camera. The Pocket Cinema Camera has an even smaller sensor than MFT, with a 2.9x crop factor compared to full frame cameras.

Like all mirrorless cameras, you can use adapters to attach SLR lenses to your camera (though you might lose sharpness, autofocus, and aperture control, depending on the lens and adapter). Non-professionals should generally avoid the use of adapters with MFT because the severe crop factor drastically changes the lens focal length and quality. Professional videographers frequently use adapters with the Pocket Cinema Camera and GH2/GH3/GH4 cameras.

To partially offset the effect of the crop factor, MetaBones has created a series of Speed Booster adapters. These adapters work exactly like a teleconverter, except opposite. Whereas a teleconverter spreads the light from just the center of the lens over the camera sensor, a speed booster focuses the light from the lens onto a smaller sensor.

For example, if you connect a 50mm f/1.4 lens to a MFT camera with a traditional adapter, it would behave like a 100mm f/2.8 lens on a full frame camera. With the Nikon G to Micro Four Thirds Speed Booster (*http://sdp.io/nmftsb*, $400), the lens would behave like a 75mm f/2 lens.

This table summarizes the current Micro Four Thirds Panasonic and Olympus cameras. They all have similar 16 megapixel sensors.

Model	Price (new)	Price (used)	Touch screen	Tilt or Articulating Display	Wi-Fi	EVF	FPS	IBIS	Video
Olympus PEN E-PM2	$290	$210	*				8	3-axis	1080i
E-PL5	$450	$340	*	Tilt	*		8	3-axis	1080i
E-PL7	$700		*	Selfie	*		8	3-axis	1080p
E-P5	$685	$575	*	Tilt	*		9	5-axis	1080p
Olympus OM-D E-M10	$700	$650	*	Tilt	*	*	8	3-axis	1080p
E-M5	$670	$550	*	Tilt	*	*	9	5-axis	1080i
E-M1	$1,350	$1,150	*	Tilt	*	*	10	5-axis	1080p

Panasonic Lumix GF6	$360	$350	*	Tilt	*		4		1080p
GM1	$575	$500	*		*		5		1080p
GM5	$900 kit				*	*	5.8		1080/60p
G6	$650	$550		Articulating			7		1080/60p
GX7	$800	$650	*	Tilt	*	*	5	2-axis	1080/60p
GH2		$450	*	Articulating		*			1080p
GH3	$1,100	$900	*	Articulating	*	*	6		1080p
GH4	$1,700		*	Articulating	*	*	12		4k

Olympus

Olympus, a Japanese company, made their first film cameras in 1936, and have been making cameras and optics ever since. In 2008, they joined Panasonic to launch the Micro Four Thirds (MFT) system for digital cameras.

Olympus is known for two series of mirrorless cameras:

- **PEN**. Compact, inexpensive, and capable compact cameras designed for casual photographers. Olympus made film cameras using the Pen name from 1959 until the early 1980s, and resurrected the name in 2009 for digital cameras. The PEN cameras do not include a viewfinder, so you'll rely on the back of the camera to frame your shots, which works fine for casual photography. Though you can add an optional viewfinder (such as the Olympus VF-1, VF-2, VF-3, or VF-4), if you want a viewfinder, you should probably just choose an OM-D model.
- **OM-D**. Rugged, retro, and DSLR-like cameras designed for more serious photographers. Olympus made film cameras using the OM name from 1972 until 2002, and resurrected the name in 2012 for digital cameras. Olympus seems to have indicated that they're focusing all their future efforts on the OM-D cameras, and dropping further PEN development.

PEN E-PM2 ($290 new, $210 used)


OLYMPUS
INFO
OK
MENU

Olympus' entry-level camera is an amazing value. It's small, light, and inexpensive, but produces the exact same images as every other Micro Four-Thirds camera.

For the sake of argument, let's compare the $290 E-PM2 to the $1,350 E-M1. The E-M1 has a glorious viewfinder that's better than real life, it takes 8 frames per second, and you can shower with it. But if you chose the E-PM2 instead, you'd have an extra $1,050 to spend on lenses, and that could buy you:

- Panasonic 20mm f/1.7: $350
- Olympus 45mm f/1.8: $330
- YongNuo YN-560 II flash: $75
- Manfrotto MKC3-H01 Tripod: $45
- Flashpoint 180 Monolight: $200
- Tony Northrup's Beginning Photography Videos 4 DVD set ($50)

That's not to say the E-M1 isn't a better camera than the E-PM2; it definitely is. But the E-PM2 and $1,000 worth of extra lenses, a flash, and a tripod will definitely take better pictures than an E-M1. In other words, don't spend your whole budget on your camera body, and don't underestimate entry-level cameras.

PEN E-PL5 ($450 new, $340 used)

Compared to the base model E-PM2, the E-PL5 adds an articulating screen, which makes it easier to shoot from high or low angles, and to take selfies. I love an articulating screen and use it regularly, however, it does add some weight and bulk to the camera.

This model also adds built-in Wi-Fi, so you can more easily transfer photos to your smartphone. With the E-PM2, you need to use a special SD card to access pictures wirelessly.

PEN E-PL7 ($700 new)

The PEN E-PL7 is very similar to the older E-PL5. The video quality has been improved by supporting 1080p instead of 1080i. The biggest difference, however, is that the tilting screen has been upgraded to a selfie screen, as shown by the following product image. Olympus has also improved autofocusing.

PEN E-P5 ($685 new, $575 used)

Compared to the less expensive PEN cameras, the E-P5 upgrades to 5-axis image stabilization over the standard 3-axis image stabilization. According to Olympus, you'll only notice the difference when shooting close-up macro photos. While it's difficult to test (since testing it requires hand-holding the camera), we've found that 5-axis stabilization does give us more usable shots as slow shutter speeds than 3-axis stabilization. It's a minor difference, however.

Perhaps more importantly, the E-P5 adds more dials for manual control. These dials are critical to any serious photographer, because they allow you to adjust the aperture, shutter speed, or exposure compensation quickly. With candid photography, they are often the difference between getting and missing the shot. Because of those dials, I'll recommend the E-P5 over the other PEN cameras for anyone who is even slightly serious about photography.

The E-P5 also provides access to ISO 100 and a maximum shutter speed of 1/8000th. Though you'll probably never need either, serious photographers working in bright light with professional lenses will appreciate the upgrade. The E-P5 also looks and feels better than the less expensive PEN cameras.

OM-D E-M10 ($700 new, $650 used)

Video: E-M10 Review	

20:49 *sdp.io/em10review*	

Video: E-M10 Travel Review (& E-M1 Comparison) **12:33** *sdp.io/em10travel*	

The E-M10 is the baby of the OM-D series of cameras, and it's my single favorite camera for travel and casual photography. It's stylish, light, capable, inexpensive, and fun. The Panasonic 20mm f/1.7 pancake lens is simply perfect with it; it's sharp enough to crop, and the in-body image stabilization and fast aperture make the combination amazing for low light.

It feels a bit plasticky, and the E-M10 lacks the durability of its bigger brothers, the E-M5 and E-M1. However, I've dragged it thousands of miles, through storms and blizzards, and never used a bag or lens cap. I abuse my gear, and it's durable enough for me.

Like all other current Micro Four Thirds cameras, the autofocusing can be frustrating in low light. At times, I wish it had a couple more customizable buttons. The viewfinder isn't as fast or beautiful as the E-M1. However, those drawbacks aren't enough to stop us from bringing this camera everywhere, and we've owned almost every modern camera.

OM-D E-M5 ($670 new, $550 used)

Olympus' mid-range OM-D camera, the E-M5, has essentially been replaced by the newer and more fully-featured E-M10. Compared to the E-M5, the E-M10:

- Is a bit less expensive new
- Is a bit lighter
- Has built-in WiFi
- Has HDR, an intervalometer, and other software-based features

Compared to the E-M10, the E-m5 is more weather-sealed and sturdier. If you already have an E-M5, it's probably not worth it to upgrade. But if you're buying new, I'd recommend the E-M10 instead.

OM-D E-M1 ($1,350 new, $1,150 used)

Video: E-M1 vs X-T1 41:03 sdp.io/em1vxt1	

Video: E-M1 vs X-T1 Autofocus Comparison 9:05 sdp.io/em1af	

Olympus' flagship mirrorless camera is also the ultimate Micro Four Thirds body. The OM-D E-M1 is clearly designed to steal market from DSLR camera bodies by shattering the perception that mirrorless cameras are flimsy and not suitable for professional use.

The E-M1 is certainly not a delicate camera. It feels like it was carved from a solid piece of steel. It's advertised as beyond weatherproof (when used with the right lenses); Olympus' own ads show it being drenched in the water.

The E-M1 has more than enough buttons, dials, and switches for any photographer, and they can all be customized to your needs. Like the other OM-D cameras, it has a tiltable touchscreen. The look and feel of the E-M1 are beyond reproach; it feels better in my hands than any other mirrorless camera I've ever used. The viewfinder is simply gorgeous: fast, bright, and detailed.

But the E-M1 is not be the right camera for most people. The single biggest benefit of the Micro Four Thirds architecture is the small size, and this camera is as heavy as an APS-C DSLR. In the DSLR world, bigger and more expensive cameras also advertise bigger sensors and better image quality, but the E-M1 has about the same image quality as all Micro Four Thirds cameras, even those costing less than $500.

The E-M1's focusing system works well for still subjects, and it does a decent job of tracking a walking subject. It's not able to accurately track a running person, however. Though Olympus advertises this camera as having phase detection autofocus, that system only works with adapted Four Thirds lenses. When you use it with native Micro Four Thirds lenses (which most will do) it will use old-fashioned contrast based focusing, which is frustrating in many scenarios.

If you like the design of the E-M1 but you'd prefer a lighter camera, or you want to save some money for lenses, consider the E-M10. The E-M10 doesn't have as many buttons, making it a bit clumsier for advanced users, and it has only three-way In Body Image Stabilization instead of five-way, but I never noticed much difference. For my video review and comparison of the two cameras, visit *http://sdp.io/em1v10*.

If you like the weight, size, and controls of the E-M1 and you're not yet invested in Micro Four Thirds, you should also consider the Fuji X-T1. The X-T1 can track running subjects better (with some tweaks applied to the focusing system) and the image quality is far better than the E-M1. However, the E-M1 has far better usability than the X-T1. These two videos will help you decide which you prefer:

- *Fujifilm X-T1 vs Olympus O-MD E-M1: http://sdp.io/xt1vem1*
- *Fujifilm X-T1 vs Olympus O-MD E-M1 autofocus rematch*: http://sdp.io/xt1vem1af

Panasonic

Panasonic doesn't have Olympus' long history of making cameras (they released the first Lumix camera in 2001), but their Lumix cameras all take the same lenses and flashes as the Olympus cameras. Therefore, you can switch between the brands without selling all your gear, and if you have a Panasonic camera and find an Olympus lens that you like, you can use it without worry.

Panasonic cameras differ from Olympus cameras in a couple of ways:

- While all the Olympus cameras have in-body image stabilization (IBIS), only the Panasonic GX7 has IBIS. IBIS allows you to hand-hold non-stabilized lenses (such as most prime lenses) for longer.
- Panasonic lenses tend to have imagine stabilization built-in (because the feature is lacking in the camera body) while Olympus lenses do not have image stabilization.
- Panasonic lenses come with lens hoods, while you'll usually need to buy a separate lens hood for an Olympus lens.
- Panasonic prioritizes video capabilities, and many of their cameras have useful video features that other brands lack, such as the ability to carefully control video color and codecs.

GF6 ($360 new)

The baby on the Panasonic lineup, the GF6 offers the same still image quality as the rest of the Micro Four Thirds lineup, making it an excellent value. The tilt screen offers versatility, and even flips 180 degrees to make selfies easier. In fact, it offers many benefits to the selfie generation, including easy connections to Android smartphones that support NFC and to Wi-Fi networks.

If you want to control your aperture, shutter speed, and exposure compensation, you'll want to look to the rest of the lineup for more powerful controls. For the casual photographer stepping up from a camera phone or point-and-shoot, the GF6 is an excellent choice. You might consider upgrading to the G6 or GX7 if you want to use flash, because the GF6 lacks a hot shoe. Upgrading to the GX7 also adds in-body image stabilization, which is only useful if you plan to use prime or Olympus lenses without stabilization.

GM1 ($575 new, $500 used)

The GM1 is a small, lightweight, retro-styled camera perfect for travel and casual photography on-the-go. The diminutive size makes it the ideal take-everywhere camera, but it feels more solid and serious than the GF6. However, the size can also make the buttons more challenging to use. It relies on the touch screen for common tasks such as changing the aperture or shutter speed, or even manually focusing with the kit lens, which will frustrate more serious photographers.

In fact, it's so small, that many smaller MFT lenses, such as the popular Panasonic 20mm f/1.7, are taller than the camera itself, preventing it from sitting flat on a table. This camera also lacks a grip, making it less pleasant to hand hold for extended periods of time. You can, however, buy an optional grip that adds size and weight to the GM1, helping it balance many lenses.

Despite its size, the GM1 is capable of taking the same high quality pictures as the rest of the Micro Four Thirds Lineup. If you plan to use prime lenses that don't have image stabilization, you might consider one of the Olympus PEN cameras instead, because those bodies have image stabilization built-in. With the GM1, you will need to choose lenses that have image stabilization.

The GM1 includes both a mechanical shutter and an electronic shutter. Thanks to the electronic shutter, the maximum shutter speed is an outrageous 1/16,000th. That's rarely useful, though; you'd need an incredible amount of light for such a fast shutter speed. Unfortunately, this novel design limits the sync speed (the maximum shutter speed you can use with a flash) to 1/50th of a second. That can be a problem if you plan to use fill flash outdoors for portraits.

If you're considering the GM1, you might consider upgrading to the larger GM5, G6, or GX7 if you want to use flash, because the GM1 lacks a hot shoe. Upgrading to the GX7 also adds in-body image stabilization, which is only useful if you plan to use prime or Olympus lenses without stabilization.

GM5 ($900 new kit)

The GM5 is the smallest Micro Four-thirds camera with an electronic viewfinder. The small size can make it difficult to place sufficient buttons and dials, but there is a single main click dial easily accessible with your thumb, allowing you to adjust the aperture or shutter speed easily. More serious manual settings will require multiple presses and turns.

Unlike the GM1, the GM5 has a hot shoe so you can use an external flash. Another nice feature of this camera is silent mode, which uses an electronic shutter to take a picture without making any noise.

You might consider upgrading to a GX7 for easier access to manual controls and a tilting touch screen. If you prefer to use your left eye with the viewfinder, you might be happier with a G6 or GH4, which have a central viewfinder aligned with the lens. If you prefer to use the display on the back of the camera instead of the electronic viewfinder, you'll probably be happy with the less expensive GM1. The GM1 also fits more easily in your pockets because the viewfinder doesn't protrude.

G6 ($650 new, $550 used)

The G6 is Panasonic's mid-range DSLR-like camera. By DSLR-like, I mean that it physically looks like a traditional DSLR, with a deep grip, rugged looks, and a viewfinder centered over the lens rather than placed in the upper-left corner.

The centered placement of the viewfinder is a requirement for SLRs because of the mirror that physically bounces the light from the lens through the viewfinder. However, mirrorless cameras like the G6 have an electronic viewfinder that can be placed anywhere on the body. The centered viewfinder causes the back of the camera to press against your nose, making it less comfortable for most photographers. However, photographers who use their left eye to shoot might find the centered viewfinder more comfortable.

The G6 has excellent controls, with both a main dial and secondary dial that are easy to access. This allows you to rapidly change the shutter speed and aperture.

Compared to the less-expensive Panasonic cameras, the G6 is less portable but much more flexible. If you'd like most of that flexibility in a smaller package, consider the GX7. I would only upgrade to the GH4 if you want to record 4k video (which is overkill for most amateurs).

GX7 ($800 new, $650 used)

While still very compact, the GX7 offers many features serious photographers will appreciate, including a main dial for setting the aperture and shutter speed, and a touch screen that simplifies selecting a focusing point (even when your eyes is to the tiltable viewfinder). The grip feels good in the hand, too.

The GX7 also includes in-body image stabilization (IBIS) allowing you to hand hold lenses that don't have image stabilization built-in. This makes primes such as the Panasonic 20mm f/1.7 and the Olympus 45mm f/1.8 much more usable in low light conditions. While the IBIS isn't as robust as that included with the Olympus OM-D E-M5 or E-M1, you'll probably never notice the difference. You will, however, notice that it lacks the viewfinder hump in the middle of the body, making it much easier to carry.

GH2 ($450-$500 used)

After Canon released the 5D Mark II with its 1080p support, everyone wanted to jump into DSLR video to take advantage of the large sensors and high-quality lenses that had been designed for still photography. The GH1 and more popular GH2 were Panasonic's answer to that—cameras designed to look and feel like a DSLR, but act more like a video camera (while still being a capable still photography camera).

In many ways, they're superior to full-frame DSLR video:

- Smaller size
- Lower cost
- More depth-of-field
- Clean HDMI out
- Electronic viewfinder visible while recording
- Touch screens
- In the US, no 30-minute recording limit

The GH2 revolutionized videography and helped secure the entire MFT format. Many videographers, including the author, switched from Canon to Panasonic for videography.

While the GH2 is no longer made, it still deserves mention because used models are available for less than $500, and with the right lens, they provide incredible sharpness and video quality. Getting the color right is a challenge, however; the GH2 is known for having a green color cast in video.

The GH2 (and GH3) cameras can be hacked, which replaces their firmware with a version that's not officially supported by Panasonic but can improve video recording quality. These hacks can lead to unreliable operation, though, so use them only if you really need them. In my personal experience buying used GH2s, I purchased some that had been hacked and some that had not been hacked, and the hacked models would randomly stop recording.

GH3 ($1,110 new, $900 used)

The follow-up to the GH2, the GH3 adds the ability to send sound over the HDMI cable. If you plan to record the on-camera audio through HDMI, you'll need that feature. The GH3 also increases the size of the body and improves the controls, allowing you to more quickly select a shutter speed, aperture, exposure compensation, and focusing point.

Many people report that the GH2 had slightly better video quality than the GH3, and as a result, many videographers prefer the older camera. Overall, the GH3's bigger size and better controls make it a superior camera, albeit at a slightly higher price used.

GH4 ($1,700 new)

Video: GH4 Review 40:58 *sdp.io/GH4review*	

Panasonic's latest video-oriented camera is physically very similar to the GH3, but offers a substantial improvement: 4k video.

Panasonic offers an optional interface unit for the GH4 featuring XLR audio inputs, allowing you to record audio directly to the GH4 and improve your audio quality without using a separate recorder.

If you're interested in 4k video, the GH4 is currently your lowest-cost option. You might also consider the $3,000 BlackMagic Design Production Camera 4k (*http://sdp.io/bm4k*), which supports full-frame Canon lenses.

Mildly interesting trivia: Panasonic has usually avoided using the number '4' in their product names because of superstition in some Asian markets. For example, they skipped from the G3 to the G5, and from the GF3 to the GF5. I think they included the 4 in the GH4 name simply because it coincides perfectly with the 4k video feature.

Kodak

Kodak also offers a Micro Four-thirds camera: the PixPro S-1 ($465). Actually, Kodak as a company has little to do with this or any other modern camera; they've simply sold the rights to use the Kodak name. The S-1 is manufactured and supported by JK Imaging.

Of course, the purpose for using the Kodak name is to trick buyers into thinking that this camera is built upon Kodak's long history in the photography world. While the Kodak name will be enough to sell a few copies on store shelves, there's no reason to think it has any better design or support than a generic camera.

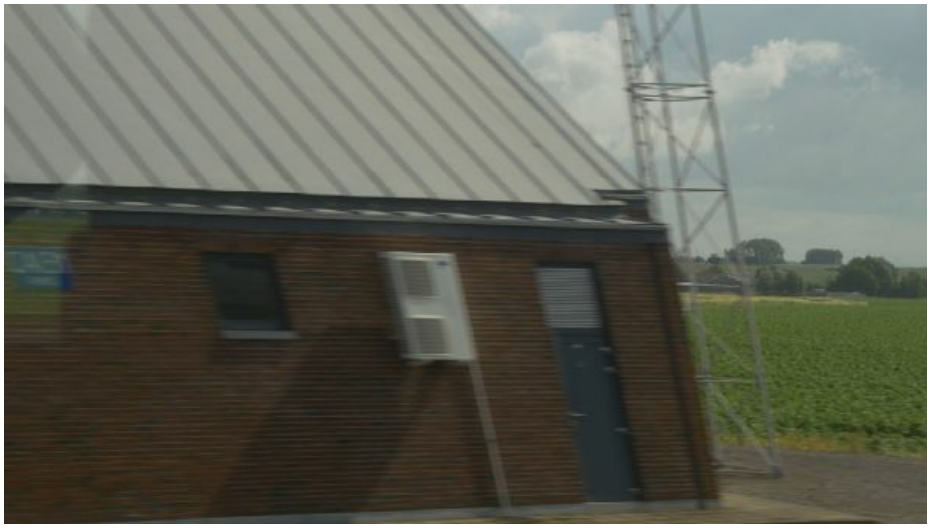
The S-1 seems like a fine camera. However, there's nothing particularly remarkable about it, and it's the only interchangeable lens camera that JK Imaging makes. Therefore, it's impossible for me to recommend it against the very similar Olympus GF-6 and Panasonic E-PL5 (which use the same lenses).

Blackmagic Design

Blackmagic Design makes several video cameras that use the MFT lens mount. This book is focused on still cameras, but the Blackmagic cameras are worth mentioning because the success of MFT video cameras has led third parties to introduce a wide variety of fast, manual focus prime lenses, greatly improving the MFT infrastructure.

Blackmagic Design cameras have several key differences. First, the video quality tends to be sharper than DSLRs. Second, the dynamic range is far greater. If you know how to grade your videos, the raw video from a Blackmagic camera will allow you to show details in a bright sky and in the shadowy foreground. With other cameras, the sky would need to be overexposed.

Another key difference between this proper video camera and a DSLR is that it has a global shutter. The global shutter eliminates rolling shutter, a problem with DSLRs that causes moving subjects to appear to lean to the side, as shown in the following still from a Panasonic GH4 video taken on a train. Obviously, the building and tower are vertical, but the all DSLRs and mirrorless cameras will render them as shown. The Blackmagic design cameras, however, render them vertical. This only matters if you're shooting action and you're serious about it; most viewers won't even notice rolling shutter.



There are numerous other differences that make the video workflow more efficient. In a nutshell, it's designed as a video camera rather than a stills camera, making it better at video.

Blackmagic Pocket Cinema Camera ($870 new, $800 used)

A pocket-sized camera with amazing HD video quality. Though it uses MFT lenses, it has a smaller sensor than other MFT cameras. Instead of the 2x crop factor of standard MFT cameras, it has a 2.88X crop factor. Therefore, even MFT lenses will be cropped.

Many videographers choose to use an adapter to attach full-frame Canon or Nikon lenses. However, the crop factor changes the performance of the lens substantially. For example, a 50mm f/1.4 lens behaves like a significantly less sharp 144mm f/4 lens. You can offset this by using the *Metabones 0.58x Speed Booster designed for use specifically with this camera*. With the Speed Booster, the crop factor of this camera becomes 1.75X.

At this price, most casual videographers should instead purchase a Panasonic GH3 because it has an articulating touch screen, an EVF, and creates more manageable video files. However, if you post-process and color grade your video, and you know that you want more dynamic range than a GH3 offers, the Pocket Cinema Camera is a better choice. Most videographers will use the Pocket Cinema Camera on a larger rig, with a focus puller and external monitor.

Blackmagic Cinema Camera ($2,000 new, $1,750 used)

The Blackmagic Cinema Camera is a bigger version of the Pocket Cinema Camera, offering higher resolution 2.5k video and a larger form factor. Unfortunately, this version has a passive MFT mount, which means it does not communicate electronically with MFT lenses. Therefore, you will need to use MFT lenses that have a physical aperture control dial (unless you want to film everything wide-open). You also won't be able to take advantage of image stabilized lenses.

As with the Pocket Cinema Camera, this camera is capable of recording raw video with incredible dynamic range, creating better-quality videos. However, this is overkill for most casual videographers.

This exact camera is also available with a Canon EF mount if you prefer to use Canon lenses. The EF mount version of this camera supports autofocus and image stabilization.

Blackmagic Studio Camera ($2,000 new for HD, $3,000 new for 4k)

Available in both HD (1080p) and 4k, these cameras are the ultimate in-studio camera. They offer features such as:

- A massive screen that makes it easier for the cameraman to focus.
- A red "tally" light that turns on so the on-camera talent knows which camera to look at.
- The ability for the cameraman to monitor the live feed from the camera's monitor (even if another camera is filming or an advertisement is playing).

These features are fairly useless outside of a multi-camera studio environment, but if you record in the studio, this is the camera you want.

Micro Four-thirds Flash Recommendations

The following table summarizes flash options for four-thirds and micro four-thirds cameras, which all support the same flashes. Because of the wide compatibility, there are dozens of flashes for these cameras. I've only listed the popular, recent, well-reviewed models.

For the zoom column, the table describes the maximum coverage range, including the coverage provided by a diffuser that you might need to manually flip down. My recommended flashes are highlighted in the table. Because manufacturers often exaggerate their flashes' guide numbers, I provided GN test results performed by third parties whenever possible.

If I've indicated that a flash supports high-speed sync, that means only that it supports high-speed sync with some camera bodies. Search for the camera model and your camera body to determine if other users have found high-speed sync to work properly and if they have identified any other compatibility issues.

Flash	Price	GN (ISO 100)	TTL	Bounce	Zoom (35mm equivalent)	High-speed sync	Manual controls	Battery pack
Metz MZ 36 AF-5	$130	36m @ 85mm	X	Tilt	28-85mm (manual)		X	
Nissin Speedlite Di 466 FT	$140	33m @ 105mm	X	Tilt	14-70mm	X	X	
Metz 44 AF-1	$189	44m @ 105mm	X	Tilt & rotate	12-105mm		X	
Metz 50 AF-1	$215	50m @ 105mm	X	Tilt & rotate	12-105mm	X	X	
Panasonic DMW-FL360	$220	36m @ 85mm	X	Tilt & rotate	18-85mm		X	
Olympus FL-600R	$300	36m@ 84mm	X	Tilt & rotate	24-84mm	X	X	
Metz 58 AF-2	$345	58m @ 105mm	X	Tilt & rotate	12mm-105mm	X	X	X
Olympus FL-50R	$500	50m @ 85mm	X	Tilt & rotate	16mm-85mm	X	X	X

Unfortunately, compatibility between the body and flash is such an important issue with four-thirds and micro-four-thirds cameras that I cannot provide overall recommendations for these flashes. For an off-camera flash, I recommend the Yongnuo YN-560 with its optical slave, but you won't be able to use it as an on-camera flash.

Chapter 17: Sony E-Mount/Alpha/NEX Mirrorless Buying Guide

Sony's E-mount cameras offer the image quality of an APS-C DSLR in a small, inexpensive package. Because of their relatively low price and amazing image quality, they're my standard recommendation for casual photographers.

In other words, if a friend asks me what camera they should buy, I'll steer them towards an NEX-3n or an a5100, depending on their budget. But those friends aren't the type who would read this guide, or even care about megapixels; they're the average casual photographer; the mom or dad who wants pictures of their kids and their vacations. As a reader of this book, you might be happier with a more advanced camera.

Model	Price (new)	Price (used)	Focusing	Tilt screen	Touch screen	Wi-Fi	Pop-up Flash	EVF	FPS	MP	Video
ILCE-QX1	$400		Good							24	
NEX-3N	$400	$230	Good	Flip-up			*		4	16	1080/30p
NEX-5T	$450	$360	Better	Flip-up	*	*			10	16	1080/60p
a5000	$500	$450	Good	Flip-up		*	*		4	20	1080/30p
a5100	$550		Best	Flip-down	*	*	*		6	24	1080/60p
NEX-6	$690	$475	Better	Tilt	*	*	*	*	3	16	1080/60p
NEX-7	$815	$680	Better	Tilt			*	*	10	24	1080/60p
a6000	$650		Best	Tilt		*	*	*	11	24	1080/60p

All the Sony APS-C mirrorless cameras are available as kits with the 16-50 f/3.5-5.6 lens, which I highly recommend. The kit lens is sharp, compact, and flexible.

They also allow charging over USB, which makes them easy to travel with. You can charge them from your laptop's USB port, or any plug-in or battery-powered USB phone charger. However, Sony does not provide a traditional battery charger with the cameras. If you want to charge your camera faster, you'll need to buy a separate charger.

The newest models, the a5100 and a6000, offer better autofocus than the older models. This is an important consideration, because even casual photographers struggled with the older models.

ILCE-QX1 ($400 new)

This unusual camera is little more than a lens mount, a sensor, and wireless communications. It lacks a display and common controls, requiring you to use a smartphone or tablet to control it.

Here's how Sony would rather have you think about the ILCE-QX1: It's a way to upgrade your smartphone to an APS-C interchangeable lens camera, allowing you to take amazing pictures and instantly post them on Twitter and Facebook.

Unfortunately, this design is so clumsy that most people don't consider it worthwhile. You need to use a plastic grip (included)

to attach it to your smartphone, and it's awkward enough that it completely eliminates the benefits of portable smartphone photography. By relying on wireless communications for the viewfinder, the lag is excessive. It costs as much as a good quality mirrorless camera or DSLR, so you aren't saving much money by foregoing the camera body.

I do anticipate deep integration between our cameras and smartphones in the future. The QX1 and its non-interchangeable lens predecessors, the QX10 and QX100 are an interesting peek into the future. The technology is not ready for me to recommend, however.

NEX-3N ($230 new, $150 used)

The NEX-3N is Sony's entry-level APS-C mirrorless body, and it's an amazing value. Other than being one of the least expensive new cameras you can buy, it's not the best at anything. Other cameras in the lineup offer 24 megapixels instead of the NEX-3N's 16 megapixels, but you won't notice the difference unless you also buy a lens that costs more than this body does new.

This camera does require some patience, however. The focusing is slow compared to the a5100 or a6000, even for still subjects. Low-light focusing can be downright frustrating. It doesn't have a viewfinder or a flash hotshoe, and the controls (for tasks such as manually setting the aperture, shutter speed, and exposure compensation) are limited. Therefore, you'll have to dig into menus if you don't like the camera's automatic settings.

You'll need to upgrade to the NEX-5T if you want a touchscreen, but the NEX-3N's screen does flip up for selfies. For the casual user, the NEX-3N offers incredible bang-for-the-buck.

NEX-5T ($350 new, $240 used)

For an extra $100, the NEX-5T is a worthwhile upgrade over the NEX-3N for many. The image quality is unchanged, but this camera autofocuses faster and more reliably, leading to less frustration. It also offers better video quality, supporting up to 1080 60p. The touchscreen is a must-have feature for those of us addicted to our smartphones.

NEX-6 ($480 new, $330 used)

The least expensive camera in the Sony lineup to offer an electronic viewfinder and a flash hotshoe, the NEX-6 is a good choice for enthusiasts on a budget. Adding an external flash can do wonders for your indoor photography, so the flash hotshoe is an important feature.

The only drawback to the less expensive cameras is that the screen doesn't flip 180 degrees for selfies.

a5100 ($550 new)

Video: a5100 Preview 12:21 sdp.io/a5100preview	

Very similar to its predecessor, the a5100 is the camera that I recommend to all my friends who want to take better pictures but don't want to actually learn photography. I wouldn't recommend it to friends who wanted to take sports or wildlife photos, however.

The a5100 is small, reasonable priced, and full of features. It's the little touches that make it such a great value: the touchscreen that flips backwards for selfies and the Wi-Fi/NFC for getting your pictures to you smartphone (and thus to your favorite social network).

I wouldn't recommend it to anyone more serious about photography. If someone even hoped to learn how f/stops or exposure compensation worked, I'd steer them to the a6000 instead for its electronic viewfinder and better controls. However, the a6000 lacks the selfie touchscreen, which makes this a better choice for the casual photographer, regardless of the price.

NEX-7 ($880 new, $460 used)

Formerly the king of Sony's E-mount lineup, the NEX-7 has been replaced in most ways by the more capable and less expensive a6000. I would never recommend buying a new NEX-7, since the a6000 focuses faster, has a standard flash hot shoe (instead of Sony's proprietary hot shoe), and is also less expensive new.

However, used copies can save you a few dollars compared to an a6000, and provide fantastic image quality and great manual controls.

a6000 ($600 new, $540 used)

Video: a6000 Review 15:16 *sdp.io/a6000review*	

The top-end camera in Sony's E-mount lineup, the a6000 is a solid all-around camera for users who might want to manually adjust camera settings, including aperture, shutter speed, and exposure compensation. If I'm travelling light and wanted to take professional-grade landscape photos, I'll grab the a6000.

My one complaint about the a6000 is the lack of a touchscreen. Without a touchscreen, learning to use the camera is a little more difficult, and common tasks like reviewing pictures and focusing during video is slower. If a touchscreen is a priority, choose the a5100 instead. Note that choosing the a5100 requires you to give up the electronic viewfinder, flash hot shoe, and some useful buttons and dials.

Video: a6000 vs E-M10 19:52 *sdp.io/a6000vem10*	

Sony Alpha/Full Frame Buying Guide

Just as Canon and Nikon offer both APS-C and full-frame DSLRs, and allow you to swap lenses between the systems, Sony offers full-frame mirrorless cameras. The three models are all closely related:

- The standard, 24 megapixel a7 is the best value, and the best choice for most photographers investing in this system.
- The a7R offers the greatest image quality, with 36 megapixels, but has some design flaws that make it difficult to take advantage of all those pixels.
- The a7S is a specialized camera primarily intended for low light video. Most stills photographers should avoid it because it offers only 12 megapixels of detail.

I believe full frame mirrorless cameras will eventually replace full frame DSLRs as the camera of choice for professional photographers and serious enthusiasts. The electronic viewfinders are fantastically useful, and every DSLR will seem bulky and heavy by comparison.

Today, they're the right choice for many, but not most. The most serious drawbacks, when compared to full frame Canon and Nikon DSLRs, are:

- The native lens selection is quite limited, and lenses tend to be more expensive than their Canon and Nikon counterparts.
- While you can attach a wide variety of DSLR lenses using adapters, you give up much of the benefits of using a mirrorless camera, and if autofocus works at all, it will be much slower.
- Even with native full frame E-mount lenses, tracking moving subjects with the autofocus is far less accurate than similarly priced DSLRs. DSLRs are still the best choice for wildlife and sports.

For those satisfied with the current lens selection, and those primarily interested in still subjects, the a7 family is a perfect choice.

a7 ($1,650 new, $1,200 used)

The a7 (and the other two a7 models) is an amazing camera, and the future of photography, and its predecessors will almost certainly kill DSLRs. It offers full-frame 24 megapixel image quality, similar to a Nikon D610, but in a smaller, lighter package. The electronic viewfinder provides far more information than an optical viewfinder, and the ability to adapt almost any SLR lens provides incredible versatility for photographers capable of manual photography.

This is my current favorite full-frame mirrorless camera. If you want full-frame results, an electronic viewfinder, and the smallest camera possible, the a7 is the perfect choice. If you don't mind an optical viewfinder and a bigger body, the Nikon D610 has similar image quality, better focusing, and access to a much wider selection of native lenses.

a7R ($2,300 new, $1,650 used)

The a7R is Sony's top-end mirrorless camera, but I still recommend the standard a7 to most people. While the a7R is an amazing camera, the extra resolution (36 megapixels, compared to 24 on the a7) is mostly wasted, unfortunately. The a7R has some flaws in the design that cause the shutter to vibrate the camera when taking a picture, reducing the effective resolution for many common shutter speeds, especially with telephoto lenses.

If you're considering the a7R because you want to create large, high resolution images, you should also look at the Nikon D810, because the lenses available for the Nikon tend to be sharper at a similar price point. For example, DXOMark tested the a7R with the excellent Sony 24-70 f/4 ($1,200) lens, and measured only 15 P-Mpix (Perceptual Megapixels). By comparison, the Nikon D800E (which has the same sensor), when paired with the Tamron 24-70 f/2.8 ($1,300), measures 23 P-Mpix at f/2.8. The Tamron also gathers half the light, allowing you to use a lower ISO, thus further improving image quality.

Similarly, the a7R combined with the 70-200 f/4 ($1,500) yields 23 P-Mpix. The Nikon D810 with the Nikon 70-200 f/4 ($1,400) yields 30 P-Mpix. Only the Sony 55mm f/1.8 prime proves to be sharp enough to take advantage of the a7R's sensor, with a P-Mpix rating of 30.

Of course, the D800E or newer D810 aren't the a7R. They're bigger and heavier, and they lack the amazing electronic viewfinder. If those benefits are worth giving up some sharpness, then this might be the camera for you. Otherwise, I'll steer you towards the much less expensive a7, or towards the D810, which eliminates shutter shake using an electronic shutter.

a7S ($2,500)

The Sony a7S is an amazing camera for a few, but it's not the right camera for most people.

The sensor separates the A7S from every other camera on the market. It's full-frame, but only 12 megapixels. That means that each of the 12,000,000 pixels is much larger than other full-frame cameras, and thus gathers much more light.

Sony designed a 12 megapixel sensor to optimize it for recording HD and 4k video. As a result of that optimization and the large pixels, it's simply amazing for low-light video. If that's what you need, this is the camera for you.

If you want low-light stills, just about any other full-frame camera can give you similar results once you scale the images down to 12 megapixels.

Another benefit of the a7S is that it has an electronic shutter that allows for completely silent shooting; if you must be silent and work in low light, this is an ideal camera. The Panasonic GH4 also has a silent shutter option, however, the smaller Micro Four-thirds sensor produces much more noise.

Video: a7S Preview

12:03

sdp.io/a7sPreview

Sony Flash Recommendations

The following table summarizes flash options for Sony Alpha cameras. For the zoom column, the table describes the maximum coverage range, including the coverage provided by a diffuser that you might need to manually flip down. My recommended flashes are highlighted in the table. Because manufacturers often exaggerate their flashes' guide numbers, I provided GN test results performed by third parties whenever possible.

Sony Alpha cameras work natively with Sony, Minolta, and Konica Minolta flashes. However, you can add a hot shoe adapter (such as the Pixel Flash FS-1100, $8) to work with other flashes, including those made by Canon, Nikon, and third parties. Since there are fewer options for Sony flashes, you might consider the third-party flashes described in the Nikon and Canon sections along with a hot shoe adapter. The same hot shoe adapter will allow you to control a PocketWizard or other wireless radio trigger. Avoid the Sony model, though; it's overpriced.

Note that the Nikon and Canon flash tables show the GN at 35mm. Sony does not provide standard GN information, therefore, I have included their GN information at 105mm (when available). This allows you to compare the flash output within this table only; do not compare the GNs in this table to the Canon or Nikon GNs.

Flash	Price	GN (ISO 100, 50mm)	TTL	Bounce	Zoom	High-speed sync	Manual controls	Optical slave	Battery pack
Yongnuo YN-462	$45	33m/108ft		Tilt & Rotate			X		
Yongnuo YN-560	$65	40m/131ft		Tilt & Rotate	17 to 105mm		X		

II									
Sigma EF-610 DG ST	$135	46m/151ft	X	Tilt & rotate	17 to 105mm		X		
Sigma EF-610 Super	$225	46m/151ft	X	Tilt & rotate	17 to 105mm	X	X		
HVL-F20AM	$120	20m/65ft	X	Tilt					
HVL-F43AM	$350	30m/98ft	X	Tilt & rotate	15 to 105mm	X	X		
HVL-F58AM	$500	42m/138ft	X	Tilt & rotate	16 to 105mm	X	X		X
HVL-F60M	$550	42m/138ft	X	Tilt & rotate	16 to 105mm	X	X		X

Here are my specific recommendations for different types of Sony photographers:

- **General candid family pictures**: Sigma EF-610 DG ST
- **Weddings and events**: Sony HVL-F58AM (professional) or Sigma EF-610 DG ST (amateur)
- **Posed portraits with on-camera flash**: Sony HVL-F58AM (professional) or Sigma EF-610 DG ST (amateur)
- **Sports**: Sigma EF-610 Super
- **Real estate**: Sigma EF-610 DG ST
- **Off-camera flash (for use with multi-light setups)**: Yongnuo YN-560 using the optical slave

Chapter 18: Fujifilm Buying Guide

Fuji makes remarkable, unusual, and quirky mirrorless cameras. In some ways, they're the most high-tech mirrorless cameras available. For example, the X-T1 is better at tracking quickly moving subjects than any other mirrorless camera we've ever tested, and it has the best viewfinder ever made.

In other ways, they're the lowest-tech mirrorless cameras. They certainly look retro, some of them have traditional optical viewfinders, and they lack features like HDR or decent bracketing.

Like Leica, Fuji cameras aren't right for most people, but they're perfect for a select few. You'll first need to determine whether you might be a Fuji person. Fuji people:

- Are tech-savvy, but love retro design
- Love buttons, dials, complexity, and tweaks
- Happily spend hours reading a manual and weeks mastering a camera's quirks

Fujifilm has one of the better selections of lenses, but it still pales in comparison to the lenses available for Micro Four Thirds or most DSLR systems. Of the available lenses, many of them (especially the first models released in 2012) have serious quirks, like unreliable autofocus. Nonetheless, Fuji has an excellent assortment of high-quality prime lenses that I recommend over the zooms: 14mm, 18mm, 23mm, 27mm, 35mm, 56mm, and 60mm. You also have five solid zoom lenses covering the usual focal ranges.

Fujifilm X-mount lenses have an aperture ring on the lens itself, which was common on cameras 30 years ago, but is quite unique in the world of modern cameras. You can also control the aperture from the camera, or use them in fully automatic mode. Most lenses have the aperture numbers written on the lens itself, allowing you to view or select your aperture without looking at the LCD. However, lenses with variable apertures (including the kit lens) do not have the aperture numbers written on the lens, requiring you to look at the display to view or adjust the aperture.

All the Fujifilm X-mount cameras have similar, excellent 16 megapixel image quality. Rather than a traditional Bayer red/blue/green filter, the Fuji cameras (except the X-A1) use a slightly different pixel arrangement that, in my opinion, produces slightly better-looking noise. None have a touch screen.

All Fujifilm cameras share some of the same quirks. For example, selecting a specific focusing point is slower and clumsier than on other cameras. You'll also need to change focusing modes more frequently than with other cameras. You can train yourself to do this fairly quickly, but the (relatively) clumsy interface and need to change modes will cause you to lose some candid shots during the first few weeks of use (and maybe even after that). For example:

- You can't directly change the focus point with the directional buttons, but must first push a button. Sony A-mount cameras work the same way.
- With most lenses, including the otherwise excellent kit lens, you can't manually focus when the camera is in autofocus mode.
- Regardless of the mode, you can't manually focus if you have the shutter half-depressed.
- If you enable face detection, the camera always uses the center autofocus point when it doesn't detect a face, and you can't change it.

Another quirk is that they only offer bracketing at +-1 stop. Most cameras offer at least +-3 stops, and many offer +-5 or +-7 stops. +-1 stop bracketing is almost useless, and as a result, you'll need to manually adjust the exposure compensation if you need to bracket more stops. That makes bracketing a clumsy process, and HDR is difficult to do well without a tripod.

If you read this description and thought, "I'd rather concentrate on the composition and lighting than choosing camera modes," than you're not a Fuji person, and I'd steer you towards Micro Four Thirds or Sony instead. If you thought, "That sounds like fun; I love a challenge," than you're a Fuji person.

Fujifilm Lenses

Fujifilm's lens selection can't compete with Canon and Nikon, and the lenses are priced higher than the mainstream equivalents. Nonetheless, they have the lenses that most photographers will need.

While I recommend zooms for most casual and professional photographers, in the Fujifilm world, I prefer using their primes. The reason for uniquely Fuji: the prime lenses (and fixed aperture zooms) have an aperture ring on the lens with the aperture settings marked. Therefore, you can turn the aperture dial on a prime lens to select automatic aperture, f/1.4, f/2.8, or whatever aperture you need.

The variable aperture zooms have an aperture dial, too, but they don't have the f/stops marked on them because they would be different depending on where you were zoomed to. Therefore, to select an aperture, you need to turn the dial while looking at the LCD screen. That works, but the extra step takes away from the mechanical mood that I love about the Fujifilm bodies.

My favorite walking-around lens is the 23mm f/1.4 ($800, pictured), roughly equivalent to a full-frame 35mm f/2. It's a wide-angle lens, which isn't as traditional as a normal lens, but it's easier to crop when you can't get close enough to your subject. If you prefer a normal lens, the 35mm f/1.4 ($500) is roughly equivalent to a 50mm f/2.

More casual photographers should opt for one of Fuji's image stabilized OIS zoom lenses. Fuji actually offers three normal zooms:

- **16-50mm f/3.5-f/5.6 ($230)**. Equivalent to a full-frame 24-76mm f/5.3-f/8.4, the wide-angle end of this lens makes it the best choice for casual and event photography. It's not the sharpest lens in the lineup, and focusing can be slow.
- **18-55 f/2.8-f/4 ($600)**. Equivalent to a full-frame 27-84mm f/4.2-f/6, this is Fuji's fastest zoom. It's the best choice for low light work, and it's substantially sharper than the 16-50mm.
- **18-135mm f/3.5-f/5.6 ($900)**. Equivalent to a full-frame 27-206mm f/5.3-f/8.4, this super-zoom is the right choice when you don't ever want to change lenses. Image quality is slightly compromised in favor of versatility.

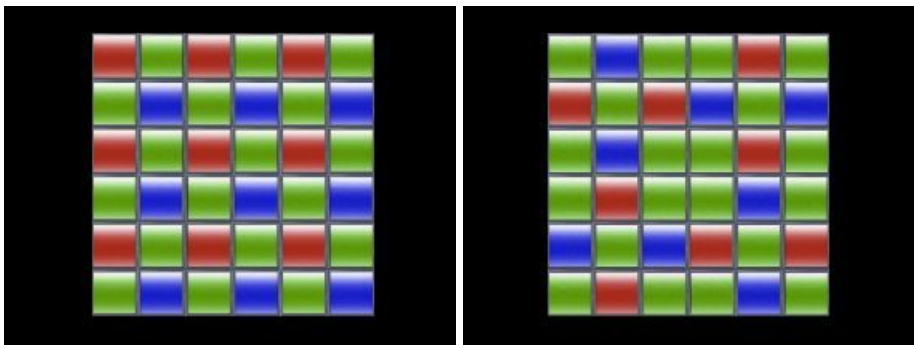
Fuji offers a solid variety of portrait lenses:

- **60mm f/2.4 ($550)**. Equivalent to a full-frame 90mm f/3.6, this isn't the most powerful portrait lens, and the focusing speed is awful. If you don't mind manually focusing, it's your best bet for getting a headshot under $1,000.
- **56mm f/1.2 ($1,000)**. Equivalent to the popular 85mm f/1.8 full-frame lens, this sharp lens offers great background blur and pleasing features for portraits. Unfortunately, it costs twice as much as an actual full-frame 85mm f/1.8.
- **56mm f/1.2 APD ($1,500)**. An upgraded version of the previous lens, this version offers nicer bokeh for portraits. Basically, it removes the rings that you see around specular highlights in the background. It also removes compatibility with phase detect autofocus systems, meaning you'll have to use the much slower contrast detection autofocus, slowing down your portrait sessions and reducing the number of keeper shots. It's hard to justify for most buyers at this price, but wealthy Fuji fans will adore it.
- **50-140mm f/2.8 OIS ($1,600)**. Pictured next, this is Fuji's equivalent of the full-frame 70-200 f/4 lens, with image stabilization. While prime lenses are fun for portraiture, a zoom is almost a requirement for professional portrait work, because the zoom allows you to quickly switch between headshots and wider angles, capturing expressions and changing compositions without moving yourself or your subject. As with most Fuji lenses, this lens is expensive, costing twice as much as the full-frame equivalent from Canon, and priced higher than the excellent Tamron 70-200 f/2.8 which offers better background blur. If you're invested in the Fuji world, this is your best option for a working portrait lens.

Fujifilm Sensors

Fuji's X-Trans sensors are one of the camera lineup's most exciting features. The X-trans sensor uses a more random-seeming red, blue, and green color filter that can improve the appearance of noise at high ISOs.

Honestly, most people won't notice the difference between the two sensors. Almost every digital camera in the world uses a Bayer sensor, but pixel peepers will appreciate the better looking shadows when compared to pictures taken with other APS-C cameras. The next figure shows a traditional Bayer filter on the left and the X-trans filter on the right.



Fujifilm Bodies

The following table, and the sections that follow, provide an overview of the current Fujifilm camera lineup.

Model	Price (new)	Price (used)	Focusing	Tilt screen	Wi-Fi	Pop-up flash	EVF	FPS	Video
X-A1	$380	$270	Good	*	*	*		5.6	1080/30p
X-M1	$500	$400	Good	*				5.6	1080/30p
X-E1	$600	$400	Good			*	*	6	1080/30p
X-E2	$940	$800	Better		*	*	*	7	1080/60p
X-Pro1	$1,200	$700	Good				*	6	1080/30p
X-T1	$1,300	$1,200	Best	*	*	External included	*	8	1080/60p

X-A1 ($380 new, $270 used)

Fujifilm's entry-level camera provides about the same image quality as all the other bodies in the X-mount lineup, in a small, sturdy, and good-looking package. It's so good, in fact, that I recommend it over the X-M1 to most photographers.

You might consider upgrading to the X-M1 for its X-trans sensor, which can improve the appearance of noise at high ISOs. The X-M1 feels a bit better in the hands, too. The differences are fairly minor, however.

X-M1 ($500 new, $400 used)

The X-M1 offers a better look-and-feel than the X-A1, and also replaces the X-A1's standard Bayer sensor with Fujifilm's proprietary X-trans sensor. Other than the difference in the filters, the X-M1 feels better than the X-A1. If you want a viewfinder and don't mind giving up the articulating display, upgrade to the X-E2.

X-E2 ($800 new, $650 used)

Compared to the X-M1, the X-E2 adds an electronic viewfinder and several buttons, simplifying manual control. The X-E2 also provides 1080p video at 60 fps, instead of just 30 fps. However, it loses the X-A1's articulating display, making the X-A1 a better choice for the casual photographer.

The EVF on the X-E2 is excellent, but it will be a bit difficult to see in bright sunlight.

X-Pro1 ($900 new, $575 used)

The X-Pro1 is Fujifilm's top-of-the-line viewfinder-style camera. In both look and feel, the X-Pro1 closely resembles one of my favorite medium format film cameras of all time: the GW690 (and its sequels).

The X-E2 has a unique viewfinder that can switch between a traditional optical viewfinder and an electronic viewfinder. The optical viewfinder behaves like older viewfinder film cameras; if you zoom in or choose a telephoto lens, the viewfinder doesn't change. Instead, the camera shows crop lines in the viewfinder marking the edges of your picture. If you miss your old viewfinder film camera, you'll love it. Otherwise, I'll steer you to the X-E2.

Most people will prefer the electronic viewfinder. As an EVF, however, it's rather slow and grainy compared to newer

Fujifilm cameras, including the X-E2 and X-T1. That won't matter much for the types of photography this camera is best at: travel and street photography.

Likewise, the autofocusing is slow and unreliable compared to some newer mirrorless cameras at this price, especially the X-T1. If you buy a used X-Pro1, be sure to install the latest firmware update; it greatly improved focusing speed with several important lenses, which makes the camera much more usable.

X-T1 ($1,300 new, $1,100 used)

The X-T1 is Fuji's top-end camera, and the improved technology is a relatively small part of what separates it from the rest of the lineup. More significantly, it's bigger, heavier, weatherproofed, and is designed more like an SLR than a viewfinder. That means the viewfinder is in the center of the camera, aligned with the lens, rather than the upper-left corner. Most photographers who use their right eye find the rangefinder design of the other cameras to be more comfortable, but SLR users will be comfortable with the X-T1.

Video: E-M1 vs X-T1 **41:03** *sdp.io/em1vxt1*	

Video: E-M1 vs X-T1 Autofocus Comparison **9:05** *sdp.io/em1af*	

Chapter 19: Nikon 1 Buying Guide

Nikon's mirrorless lineup is much more complete than Canon's, and will appeal to many photographers loyal to Nikon DSLRs and fixed lens cameras. However, if you haven't yet invested in the Nikon 1 system, I'll instead steer you to the alternatives from Sony, Olympus, and Panasonic, which offer better image quality and a better native lens selection.

First, I'd like to warn you about one of the biggest selling points of the Nikon 1 system: compatibility with Nikon's DSLR lenses. Yes, you can buy the Nikon F-T1 adapter ($210) to connect a Nikon 1 mirrorless camera to your DSLR lenses. However, focusing is generally awful compared to DSLRs. Also, the CX sensors mean that the crop factor is severe (2.7X), making a 50mm f/1.4 lens behave like a very unsharp 135mm f/3.8 lens. Attaching a large lens to a tiny body also means the handling is awkward, because the camera will be extremely unbalanced.

With those warnings aside, the Nikon 1 series mirrorless cameras are simply tiny, priced great, and create very usable images. They make a great second camera for a DSLR owner. This chapter will give you an overview of the different bodies.

S1 ($340 new for a kit, $200 used)

Nikon's entry-level mirrorless camera provides just the basics, but gets the job done. By "just the basics," I mean that it has a relatively low resolution 10 megapixel sensor, which is still large enough for the types of pictures most people will take. It has very few buttons, requiring you to go into the menu system to take manual control of the camera.

The S1 simply isn't a camera designed for photographers that want manual control; it's essentially a point-and-shoot camera with interchangeable lenses. Because it's readily available at about the same price as the more powerful J3 (announced at the same time), I recommend the J3 to most photographers.

J3 ($366 new for a kit, $200 used)

For most people reading this guide, the J3 is a better choice than the S1, with a 14 megapixel sensor and additional buttons that make it easier to take manual control. Still, if you plan to use manual mode, regularly adjust settings, or you want to hold your eye to a viewfinder, you might consider the Nikon 1 V3 instead.

V3 ($1,200 for a kit)

Video: Nikon 1 V3 Preview 11:37 *sdp.io/n1v3preview*	

The V3 is Nikon's top-end mirrorless camera, and it's designed for enthusiasts. However, at $1,200, it's very hard for me to recommend over other less expensive mirrorless cameras, such as the Olympus E-M10 or Fujifilm X-Pro 1.

Nonetheless, if you're already invested in the Nikon 1 system, the V3 provides the ultimate experience. Nikon crammed 18 megapixels into the tiny sensor, and gives you incredible features, including Wi-Fi and 1080/60 fps video.

Being able to capture 20 pictures in a second is fairly amazing, but if you're attempting to focus on a subject that's moving towards you or away from you, a fairly large amount of those pictures will be out-of-focus. However, since the lenses provide a great deal of depth-of-field, you might not notice any focusing issues.

The V3 does have an electronic viewfinder. However, it attaches separately to the top of the camera. Most users who prefer to use the EVF choose the older version of this camera, the Nikon 1 V2.

AW1 ($750 new for a kit)

The AW1 is the world's only interchangeable lens mirrorless digital camera. If you plan to regularly use your camera underwater, I suggest buying the kit. It's still a capable camera on land, but it's definitely optimized for underwater use.

Chapter 20: Canon EOS M Buying Guide

Canon is the #1 manufacturer of DSLRs, but their effort to address the growing mirrorless interchangeable lens market came rather late. Some might even say their efforts are half-hearted, and that they'd prefer you buy a DSLR instead.

Perhaps their biggest selling point is compatibility with existing Canon EOS lenses using the EF lens adapter ($135). Indeed, the adapter does work, and you can autofocus with your EOS lenses. However, if you already have Canon lenses, you probably also already have a Canon DSLR, and I find it makes little sense to attach the M to a Canon EOS lens. You lose the size benefits the mirrorless system can bring, as well as the focusing and viewfinder benefits of a DSLR. In other words, attaching the M to an EOS lens gives you the worst of both worlds, in many ways.

If you take my advice and avoid adapting lenses, Canon offers you two native lenses:

- 22mm f/2 ($250) pancake lens (equivalent to 35mm f/3.2)
- 18-55mm f/3.5-5.6 IS ($300) (equivalent to 29-88mm f/5.6-f/9)

That's it! No portrait lens, no super-wide angle lens, no fast normal prime, no sports lens, no wildlife lens.

As you might have inferred, I can't recommend the EOS M system. It's my least favorite of all the mirrorless systems, and even Canon seems to have abandoned it. Nonetheless, if you love Canon and the 35mm-equivalent focal length feels right to you, the M with the 22mm f/2 lens makes a great, compact, walking around camera suitable for street photography, and the kit costs only $450. If you'd prefer a zoom lens, I'd direct you to the fixed-lens PowerShot series instead.

EOS M ($265 new, $240 used)

Released in 2012, Canon's first mirrorless interchangeable lens camera features an 18 megapixel APS-C sensor, 1080p video, hybrid focusing, and a touch screen. Functionally, it's quite similar to their lower-end APS-C DSLRs (with a 1.6X crop), and you can expect similar image quality (but in a smaller form factor).

It lacks a viewfinder, so you'll need to use the back of the camera to frame and focus your shot. The focusing system is capable for a mirrorless camera, though because mirrorless focusing is advancing quickly, it doesn't keep up with the latest generation of cameras, including the Sony a6000 and Fujifilm X-T1.

EOS M2 ($350 new, if you can find one)

In December of 2013, Canon released an updated EOS M camera: the M2. However, they didn't release it in the United States, and instead continued to sell the original EOS M camera. You can buy the M2 on eBay, however.

The M2 offers significantly improved hybrid autofocus, and claims to focus 2.3 times faster than the original M. It's also about 10% smaller than the original M. Otherwise, the cameras are identical.

Chapter 21: Leica Buying Guide

This chapter provides an overview of Leica's two mirrorless camera systems: The newer, less expensive T and the legacy M system.

Leica T Buying Guide

The T is Leica's entry-level mirrorless interchangeable lens camera, if you can call a $1,850 camera body with only $2,000 lenses entry-level. It has the 18 megapixel APS-C sized sensor from the Sony NEX-3n ($400), so you can expect similar image quality. Also like Sony, Fuji, and most other mirrorless cameras, you can use an adapter to attach Leica M lenses to the body.

Leicas are always special, however, and the T is no exception. Several aspects make it unique:

- **An unusually large 3.7" touch screen**. The touch screen replaces most physical controls, creating a very simple design. However, I personally prefer physical buttons because they allow me to change settings more quickly.
- **It's carved from a solid block of aluminum**. While this sounds quite cool, you can necessarily assume that the entire camera is more durable or weatherproof than its alternatives. In fact, composite materials often absorb the shock of being dropped better than solid metals, which pass the shock on to internal components.
- **It has no image stabilization**. Leica claims adding image stabilization to their lenses would reduce optical quality, and they're not willing to compromise that quality. I'm not sure this philosophy is practical, because I've used image stabilized lenses that were both sharper and less expensive than Leica lenses, and the in-body image stabilization systems offered by Panasonic and Olympus don't change the optics. Also, I would argue that camera movement has a greater negative impact on image quality than image stabilization.

The T has neither an optical nor an electronic viewfinder, however, you can attach the optional Visoflex electronic viewfinder ($600) to the flash hotshoe. It's useful, with tilt and GPS, but it makes the Leica even clunkier, and it costs as much as an a6000.

Currently, there are only two native lenses for the T system:

- 23mm f/2 prime, equivalent to a 35mm f/3 full-frame lens
- 18-56mm f/3.5-5.6 zoom, equivalent to a 27mm-84mm f/5.2-8.4 full-frame lens

Leica has promised more T lenses in 2015. However, most Leica enthusiasts will simply use the 23mm and never feel the need to change lenses.

If you're a fan of Leica's M cameras, notice that the T lenses do not have aperture rings. I love setting the aperture using an aperture ring, but the T camera system has chosen to require the photographer to change the aperture using dials on the camera, which is a more conventional system. It *does* have autofocus, though it's only contrast-based, so it won't keep up with moving subjects.

If you like the rugged, retro, and manual aspects of the Leica systems, I recommend checking out the Fujifilm system. The image quality is similar, there are a wider variety of lenses, and it's far less expensive. An X-T1 with the kit lens is $1,700. The Leica T, with a viewfinder and a zoom lens, is $4,200.

But the Fuji just isn't a Leica.

Leica M Buying Guide

The Leica M cameras are the most prestigious 35mm cameras ever made. Their 35mm film predecessors date to 1913. After more than 100 years, surprisingly little has changed.

Sure, the new Leica M cameras are digital, but they still have the same fundamental shape and build as Leica's first camera. The viewfinder and focusing mechanisms have hardly changed since the 1930s.

The current Leica M mount was introduced in 1954, along with the Leica M3. The current model (known simply as M) would be the M10 or M240. That's 8 new generations of camera over 60 years. If you were to send an M10 back to 1954 and turn the LCD off, the only question they'd have is where the film winder is.

If that sounds wonderful to you, and you're quite rich, you might be a Leica person. But you're probably not a Leica person; very few of us are. To a Leica person, cameras have history and emotion, and technology just interferes with the photography process. With a Leica, it's about the journey, not the destination.

In the sections that follow I'll describe what distinguishes the cameras, but they all have a few things in common:

- They have an optical viewfinder
- They lack autofocus, and instead use rangefinder focusing (which I demonstrate in my review of the Leica M Monochrom)
- The focusing system needs to be professional recalibrated on a regular basis, requiring you to send it away for service. They usually need to be serviced at Leica in Solms, Germany. Thus, if you plan to use them professionally, you will need two bodies.
- They are small but heavy, with sharp edges that make them uncomfortable to hold. For best results, get a leather case.
- The electronics are slow and the menus are clumsy.

M Typ 240/M240/M10 ($6,600 new, $6,000 used)

The top-of-the-line model has a 24MP color sensor, supports 1080p video and live view. It should be called the M10 or M240, but it's known simply as M.

It's the best digital Leica, and most people will have more fun and take better pictures with a $600 Sony a6000. If you're a Leica person, and you want to go digital, and you want color, this is the camera to have. If you prefer black-and-white, check out the M-M.

M-E ($5,300 new, $4,000 used)

The current base model body, the M-E, has an 18MP color sensor, but lacks the video and live view support of the M. It's

about 20% less expensive than the M, and it's the right choice if you want an experience more like shooting film (but without the time in the dark room).

M Monochrom ($8,000 new, $6,000 used)

Video: Leica M Monochrom Review 13:27 sdp.io/mReview	

Video: Leica M Monochrom Discussion 14:31 sdp.io/mDiscuss	

Only Leica would make put the highest price on their lowest featured camera. Unlike other Leicas, this camera does have a unique technological advancement that tangibly improves the image quality.

The M Monochrom is more Leica than any of the other cameras, taking only black-and-white pictures. In our testing, the black-and-white sensor (which lacks the Bayer filter of color sensors and thus gathers about four times more light) does indeed produce less noise than color images that have been converted to black-and-white. If you want the best quality black-and-white images, this camera will give it to you.

It will not, however, capture video, provide live view, or autofocus. It's a true Leica.

Chapter 22: Samsung NX Buying Guide

While other camera manufacturers brag about their sharpness, focusing, and megapixels, it's the software that makes Samsung mirrorless cameras stand apart from the crowd. Samsung leverages their smartphone experience by creating cameras with gorgeous user interfaces that connect to the Internet and social networking better than any other camera.

Samsung also understands the younger audience better than anyone else, and you'll notice that many of their cameras have flip screens that make it easier to take a selfie. Because they're targeting younger people who probably don't yet have a camera, the cameras all have very attractive pricing, come in a variety of cool colors, and most of them are sold only as kits.

Samsung has two different lens formats: NX Mini and NX. As the name indicates, the NX Mini is smaller, with CX sensors. The NX series has larger, APS-C sensors. There's only the one NX Mini camera, and it's designed more for selfies than photography enthusiasts. We'll focus more on the full NX series cameras.

The Samsung NX cameras have an APS-C sensor, the same size as the Sony Alpha NEX and Fujifilm cameras. Like the Sony cameras, Samsung cameras can charge via USB—a huge benefit if you plan to use it when travelling. They all have about a 20 megapixel sensor and record 1080/30p video.

Like many manufacturers, more digits in the model name indicates a lower-end camera, and fewer digits indicates a higher-end camera. Therefore, the NX1 is the top-end camera because it has one digit, the NX30 is just below it, and the four-digit NX1000, NX1100, NX2000, and NX3000 are the entry-level cameras. Of the four-digit cameras, the higher numbers are generally newer and better, so the NX3000 is more camera than the NX1100.

Samsung has a solid variety of lenses, including several pancake primes which will take great, clean pictures without much size and weight. In particular, check out the Samsung 20mm f/2.8, which makes a great bring-everywhere lens.

Unfortunately, most of the Samsung zooms (including many of the kit lenses) lack image stabilization, making them difficult to recommend. Be sure to choose a zoom lens with "OIS" in the name; that's Samsung's name for image stabilization.

Samsung has three workable portrait lenses:

- **45mm f/1.8 ($300)**. I recommend the version without the 3D feature.
- **85mm f/1.4 ($850)**. This remarkable lens blurs the background substantially more than the 45mm, and the longer focal length will provide more flattering facial features.
- **50-150mm f/2.8 ($1,600)**. Equivalent to a 75-225mm f/4.2, you won't get the same background blur as you would with a 70-200 f/2.8 on a full-frame body, but it's still the best choice for fast and flexible Samsung portrait sessions.

Additionally, if you don't mind manual focus, the Rokinon 85mm f/1.4 is available for the Samsung mount.

If any camera manufacturer has a chance of joining Canon, Nikon, Sony, and Panasonic, it's Samsung. Samsung's electronic expertise has allowed it to add 4k to its newest camera at a price under $2,000, something only Panasonic has been able to do. They're also rapidly adding high-quality and (mostly) reasonably priced lenses to their lineup.

This table provides an overview of the Samsung lineup, followed by more detailed descriptions.

Model	Kit price (new)	Kit price (used)	Focusing	Screen	Touch screen	Wi-Fi	Pop-up Flash	EVF	FPS
NX1000	$350	$250	Good	Fixed		X			8
NX1100	$330	$220	Good	Fixed		X			8
NX2000	$330	$290	Good	Fixed	X	X			8
NX3000	$530		Good	Flip	X	X			5
NX300	$400	$380	Better	Tilt	X	X			8.6
NX20	$530	$450	Better	Articulating		X	X	X	8
NX1	$1,500		Best	Tilt	X	X	X	X	15

NX Mini ($400 new)

The world's smallest interchangeable lens camera won't be the right choice for most readers of this book, but it might be a great gift to someone starting in photography who requires a tiny camera.

The NX Mini isn't compatible with the other Samsung NX cameras; it has only two compatible lenses available:

- 9mm f/3.5 (24mm f/9.5 equivalent)
- 9-27mm f/3.5-f/5.6 OIS (24-73mm f/9.5-f/15 equivalent)

The 9mm prime is smaller, and if you're picking this camera to fit it into your pocket, it's the better choice. However, it lacks image stabilization, so be sure to use a faster shutter speed.

NX1000 ($350 new kit, $250 used kit)

Samsung's entry-level NX is an amazing camera for the price. Though it feels plasticky, so do other cameras at this price. It lacks a touch or tilt screen but has Wi-Fi. The biggest weakness to this kit is the lack of image stabilization, which is inexcusable, and will lead to many shaky pictures. If image stabilization is important to you, look at the NX3000 kit instead.

The NX1000 is available in white, black, and pink (but the lenses are all black). The kit includes a detachable flash (SEF-8A) that's about as awful as a typical pop-up flash.

I wouldn't buy this camera new; I'd buy the almost identical NX1100 or NX2000 instead, because they include Lightroom 4 for free.

NX1100 ($330 new kit, $220 used kit)

Almost identical to the NX1000 (released Spring 2012), including the price, the NX1100 is one year newer and includes Adobe Lightroom 4. Lightroom is photo editing software, and it's wonderful. Though Lightroom has since been updated and

doesn't provide free upgrades, Lightroom 4 is still excellent software and including it for free is a great reason to get the NX1100 instead of the NX1000. Even if you plan to upgrade to Lightroom 5 ($150), having Lightroom 4 will allow you to purchase the upgrade, which is only about $75.

You might also consider upgrading to the NX2000, which is about the same price, also includes Lightroom 4, but has a bigger display and a touch screen. I prefer the dials on the NX2000 over the NX1100, also.

NX2000 ($330 new kit, $290 used kit)

The NX2000 has the same excellent image quality as the previously described Samsung cameras, but adds a larger display, a touch screen, and moves the dials around. Like the NX1100, it includes a copy of Lightroom 4 but lacks image stabilization with the kit lens, which prevents me from recommending it unless you already plan to buy one of Samsung's OIS lenses, such as the 18-55mm ($200), 18-200mm super-zoom ($680), or the amazing 16-50 f/2-f/2.8 ($1,200).

NX3000 ($530 new kit)

Samsung's newest NX camera is compact, stylish, and capable. It's flip screen turns upwards 180 degrees, perfect for selfies or just shooting from low angles.

The extra $200 also buys you a kit with image stabilization, allowing me to comfortably recommend this camera. This model includes Lightroom 5, which saves you another $75 when compared to the NX2000.

Available in black, white, or brown faux-leather, it feels much better in the hands than the plastic of the other four-digit Samsungs. Unless you're really into selfies, I'd recommend the NX300 over this new model until the prices come down.

NX300 ($550 new kit, $470 used kit)

Technically positioned above the NX3000, the NX300 is about the same price mostly because it's been on the market a year longer. The look and feel are very similar, but the screen tilts both up and down—but not 180 degrees forward. If you're into selfies, the NX3000 is the better camera.

For most of us, however, the NX300 is superior. Most notably, it includes a hybrid autofocus system, so you'll be able to focus faster. Focusing is a common complaint about the lower-end cameras.

There are two versions of the NX300 kit. I recommend the more expensive kit with the 18-55 image stabilized lens instead of the 20-50 non-stabilized lens; image stabilization is one feature that's worth paying a bit extra for.

NX30 ($800 new kit, $700 used kit)

Samsung's almost-top-end mirrorless camera has the familiar size and shape of a DSLR. You have the option of using either the articulating screen (which lacks touch) or the electronic viewfinder. It looks and feels like a more serious camera, but the image quality is unchanged from the other Samsung cameras.

Choose the NX30 over the other Samsungs because you want a larger camera or you need the articulating screen. If portability is more important to you, check out any of the other Samsung models.

Galaxy NX ($1,000 new, $850 used)

The Galaxy NX is the perfect combination of Samsung's mobile, software, and camera businesses. It might be the most

interesting camera in this entire book, because I believe it shows the future of photography.

Smartphones spark an interest in photography for many. Smartphones aren't great cameras, but the ability to instantly edit and share photos allows photographers to get much more from their smartphone than they could from a traditional camera. The Galaxy NX combines everything you love about your smartphone with an interchangeable lens camera.

Yet, it's not a camera I recommend to many. At $1,000, it's very hard for me to recommend it over a less-expensive Nikon D5300 or Sony a6000. Either camera is better at actually being a camera; they produce better images and offer better controls than the Galaxy NX. In particular, common tasks like changing the aperture and adjusting exposure compensation are rather clumsy on the Galaxy NX because it relies on the huge touchscreen rather than physical controls. Samsung's lens and flash selection can't match those of Nikon and Sony.

The Galaxy NX has some other serious weaknesses:

- In sleep mode, it takes 4 seconds to start, and that's often enough to make you miss a moment. If it's fully powered down, it takes 23 seconds to start.
- Image quality doesn't match that of Sony & Nikon APS-C cameras.
- Autofocusing is slow and inaccurate with moving subjects.
- The software is incredibly complex, and if someone finds their smartphone to be a bit confusing, this camera will baffle them.

But the D5300, a6000, and every other camera in this book can't get your pictures edit and onto Twitter or Facebook nearly as quickly and easily. Sure, cameras offer Wi-Fi and NFC, but there's no substitute for having a touchscreen and running real Android apps on your camera.

If you aren't spooked by the price tag, you don't plan to ever use manual mode or buy serious lenses, and social networking is important to you, the Galaxy NX is your camera.

Samsung NX1 ($1,500 new)

The NX1 is Samsung's first effort to compete with the popular Canon 70D and 7D Mark II and the Nikon D7100, as well as serious mirrorless cameras including the Olympus E-M1 and Panasonic GH4. At $1,500, it's a serious camera that also has some serious limitations.

The NX1 offers some amazing specs:

- 28 megapixel APS-C sensor is more detailed than any other APS-C camera.
- 15 full-resolution frames per second is faster than all the competition, even $7,000 Canon and Nikon DSLRs.
- Full 4k 30fps video puts it squarely against the incredibly popular Panasonic GH4.

If we look only at the positives, the NX1 is by far the best camera at this price point. However, there's one important concern: lens and flash compatibility. Currently, Samsung offers a total of 12 lenses, and third parties like Tamron and Sigma don't offer any lenses with Samsung compatibility. If those 12 lenses include all the lenses you might ever want, and you feel the prices are fair, then feel free to dive into the Samsung system.

However, $1,500 can also get you a great Canon, Nikon, Panasonic, or Olympus camera, and they all have access to more than 100 lenses. Because there's more competition and greater volume for those lens mounts, the lenses tend to be both higher

quality and less expensive. This isn’t a big concern for a casual photographer buying a $500 NX3000. But the NX1 is designed for serious photographers, and serious photographers also need serious lenses.