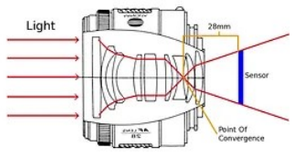
Using Lenses

How Lenses Work

Camera lenses are made up of many smaller lenses which are called elements. These elements work together to bend, straighten and focus the image. Using combinations of small lenses reduces distortion and aberrations. If you've ever used a magnifying glass, you know how much a single piece of curved glass distorts the image. Along with these groups of lenses is the lens aperture. It opens and closes to match the f-stop set by the photographer. When you turn the focus ring, a dance occurs inside the lens. Elements shift and re-arrange in order to focus the image. The front element and the rear element are crucial to the image quality of the lens. Scratches or defects on these surfaces directly affect image quality. Lens caps or protection filters should be used at all times.



Types of Lenses

Lenses capture images just like your eyes do. Your eyes do not have the ability to magnify and reduce the size of the image or the field of view, but camera lenses do allow us to change magnification and field of view. Lenses with different focal lengths see the scene in different ways. For the purpose of this lesson we will be using 35mm film or "full frame" sensor as our medium.

There are 4 major types of prime lenses. Normal, Wide Angle, Telephoto and Macro. Each type has unique characteristics.

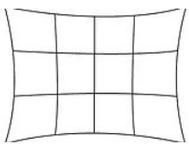
- Normal Lens - A normal lens is a prime lens that sees the world with the same field of view as the 20/20 human eye. There is no magnification. Objects are the proper size in relation to each other whether they are close up or far away. Normal lenses have focal lengths of approximately 50mm. 50mm lenses are the sharpest lens in your camera bag.

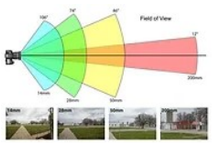
- Wide Angle Lens - Wide angle lenses have a shorter focal length than normal lenses. They allow the camera to capture more of the scene from side to side than a normal lens captures. It has a wider field of view. Wide angle lenses make objects that are far away appear small in relation to near objects. Wide angle lenses have a larger depth of field than normal lenses. A wide angle lens has more area in focus from near to far than a normal lens does. This is why wide angles are preferred by landscape photographers. Wide angle lenses, because they use glass that is curved, have a significant amount of barrel distortion. They are not recommended for portraits, partly because of this distortion. The wider the lens, i.e. the shorter the focal length, the more distortion it will have. Stray light is also an issue. Always use a lens hood with a wide angle lens.

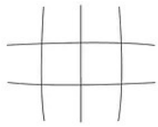
- Telephoto Lenses - Telephoto lenses have the opposite characteristics of wide angle lenses. Telephoto lenses make objects appear larger than normal and have a narrow field of view. Telephoto lenses have a shallower depth of field than either normal or wide angle lenses. Objects that are far away appear large in relation to near objects. If you've ever seen a pic of the sun over the horizon and it looks huge compared to trees or mountains in the foreground, that effect is from a telephoto lens. Telephotos have the opposite type of distortion as wide angles. Telephotos can suffer from pincushion distortion. Telephotos are preferred for portrait photography because of their tendency to blur backgrounds and let the photographer stand at a comfortable distance from the subject. Telephotos are an essential tool for wildlife photography.

- Macro Lenses - Macro lenses are specifically designed to render objects at lifesize. What does that mean? Imagine a film negative. It is 24mmx36mm. Imagine, on that negative, is an image of a dime taken with a macro lens. If you place a real dime over the negative, both dimes will be the same size. Macro lenses let you see objects closer than you can with the naked eye. Macro lenses usually have focal lengths of at least 50mm. In order to get a life size image, you must get within a few inches from your subject. Therefore, most serious macro shooters use telephoto macros. This allows you to get several more inches away from your subject and avoid blocking your own light. Macro lenses have an extremely small depth of field when used at life size distances.

- Zoom Lenses - Zooms allow you to change focal lengths without changing lenses. Zoom lenses are popular because they save space in your camera bag and eliminate the need for lens changes. They are typically of lower quality than prime lenses because of the amount of light bending which must be done inside the lens. Zooms are slower than prime lenses. 'Slower' means that that their apertures don't open as wide. Along with being 'slower' than primes, zooms usually have apertures that reduce in effective size as you zoom toward telephoto. i.e., 18-55 f4-5.6 is a typical zoom. At 18mm the f-stop is f4. At 55mm the f-stop is f5.6 . However, zooms that are made to professional standards maintain the same effective aperture size throughout the zoom range and have image quality close to that of prime lenses.







Choosing Your Lens

Which lens is best for what? Take a breath.....It depends on what you want to show in your photo. You can take a good photo of a garden with different lenses. Do you want to show the whole garden? Do you want to show the garden as part of the yard? Do you want to show one individual flower?

- Showing the whole garden. Let's assume it is a small suburban garden. You are able to see the whole garden comfortably from where you are standing. You can choose a lens that has the same field of view as your eyes. A normal lens will work fine.

- Showing the garden as a part of the yard. You may try a normal lens but you can't back up far enough to fit the garden and the yard into the photo. You need a wider field of view. You use a wide angle lens.

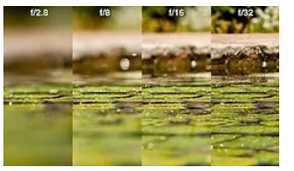
- Showing one flower. You need to either magnify the size of the subject or get really close to the flower. Either can work. You choose a telephoto to magnify the size of the flower to fill the photo. That's okay but telephoto lenses are hard to hold steady. You try a macro lens and discover that even though you are very close to the flower it is still a blurry from your hand shaking and a reduced depth of field from being so close.

What do you do? How do you steady the camera to eliminate blur from shaking? You can choose a higher shutter speed if there is enough light but when you open your aperture to compensate you lose so much depth of field that the flower is now out of focus. Use a tripod. Tripods are made specifically to hold your camera steady. Now you can choose which lens you prefer, or since most folks don't own a macro lens, you can use your telephoto.

You are still in the garden, mostly because I couldn't think of another example. You decide to use your normal lens to get a shot of several flowers together. You shoot the photo but only the closest flower is in focus. This happens because the aperture that you have chosen is large or mostly open. You check it and yep, the aperture is f4 . Your photo has a small, or narrow, depth of field. With experience you will learn how apertures affect depth of field on your lens. How do you adjust the aperture to make objects in the photo in focus from the closest to farthest

point in the photo? You close your aperture. Do this by adjusting your f-stop to a higher number. Let's choose f22. Now all of the flowers are in focus. Your photo has a large, or wide, depth of field.

Depth of Field Calculator



You take the same photo with a wide angle lens. You take it at f4 and compare to the photo taken with the normal lens at f4. They look different. The closest flower looks large compared to the distant flowers. And, most of the flowers are in focus. How did that happen? Well, keeping it simple, it's because the wide angle lens shrunk everything to fit into a smaller space. Wide angles have larger depths of field at the same apertures as normal lenses. This is one major reason why landscape photographers use wide angles. They want everything in focus, from near to far. Note: Always use a lens hood.

If wide angles have a large depth of field compared to normal lenses, what do telephotos have? Telephotos have small, or narrow, depths of field compared to normal lenses. Telephotos usually blur the background in your photo. Telephotos require a very high aperture to maintain sharp focus throughout the photo. Luckily, telephotos are primarily used for wildlife photography or portraits. In these types of photos the subject is usually a single object and having a blurred background helps make that object stand out as the subject. There is a hurdle to jump when using a telephoto lens, though.

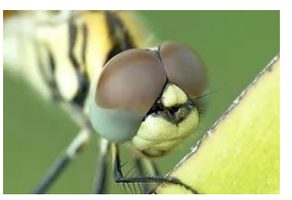
Telephotos are hard to hold steady. You must use a tripod to be totally confident that you didn't shake your camera. If you do not have a tripod you can try to steady your camera on a railing or up against a wall. But you don't always have a railing or the time to steady your camera. There is another option. Use a shutter speed fast enough to counteract camera shake, and luckily, there is an easy way to remember what to do. Use a shutter speed that matches the focal length of your lens. i.e., 1/200th second for a 200mm lens. 1/500th second for a 500mm lens. Long before lenses came with Image Stabilization, photographers used this simple rule and never regretted it. This rule is based on effective focal length.

NOTE: If you are using a Sub Frame digital camera you must use the Crop Factor to determine your effective focal length. Nikons DX cameras have a 1.5x crop factor. Canon's have a 1.6x crop factor and four-thirds cameras have a 2x crop factor. If your lens is 200mm. Multiply 200mm times the crop factor.

Example: 200 x 1.6 = 320. 320mm is your effective focal length. You would need a 1/320th secon shutter speed when using a Canon sub-frame digital slr.

Macro lenses suffer from the same narrow depth of field and motion blur as telephoto lenses. Partly because macros are often telephotos. The main reason though, is due to the nature of macro. If you ever try to look at something 6 inches from your eye you can only focus on the closest edge of that object. Everything else is blurry. Macro lenses behave the same way. If you hold something in your hand, look at it closely and move it from side to side, it will blur. It blurs more than if someone were to hold it and move it side to side ten feet away. When it is very close, the slightest movement is magnified.

Why do we need them? We need macros to see tiny details at closer range than our eyes can see. Macro lenses are like high quality magnifying glasses. They show amazing detail at close range but only the smallest area is in focus. Tripods are a necessity when shooting macro. For more specific info on macro, see Macro.



Zooms - handy, but...

Zoom lenses. When you buy a new camera it usually comes with a zoom lens. Most people never use anything but a zoom lens. You zoom in and out. Pretty simple, right? You may remember from above that zooms are slower than primes. Usually, significantly slower. This affects image quality, but how?

-All lenses have a common trait. They all perform best a mid aperture. Let's take a 50mm f1.4 for example. The f-stop range is from f1.4 to f22. It performs best at f5,6-f8. Trust me, it does. Let's take another lens, a 50mm f3.5. It has a range of f3.5 -f22. It performs best at f8-f11. Did you see what happened? The spot where the quality is best shifted because the lowest aperture was higher, the midpoint is higher. Now consider a 70-300 F4-5.6 . Yep, it's best from f8-f11 or if you're zoomed in, f11. It is unlikely that you'll be able to use it at f11. Most pics taken with a 70-300 are shot at f5.6 . So, you're sacrificing the sweet spot. But it's worse than that. Typically lenses perform worst at wide open aperture. f5.6 is wide open for a 70-300 at 300mm. So, your are forced to use high ISO settings to compensate and you end up trading sharpness for noise.

- Zooms also typically perform best in the lower middle to middle of their focal length range. So, if you have an 18-135 it will perform best from about 28mm to 75mm. A 70-300 will perform best from about 100mm to 200mm.

What happens to make the quality lower at the beginning and end of the zoom range and at wide open apertures? Vignetting, chroma, and barrel distortion are common problems which are most prevalent in wide open apertures and the widest angle setting of a wide-tele zoom lens. Stopping down the aperture (making it smaller) reduces or eliminates all three of these problems. Vignetting and pincushion distortion are common problems with the zoom set at the maximum focal length. What should you do to get the best quality from your zoom lens? Avoid shooting at the widest aperture and avoid shooting fully zoomed in.

Lens Accessories

Lens Hoods - Hoods keep stray light from entering your lens from the side. If you've ever had a bright light shine into the side of your eye when you are trying to focus on an object straight ahead you know how hard it is to focus and see clearly in that situation. As people, we place a hand over our eyes to control stray light. Lens hoods do the job our hands would normally do. Lens hoods are most important on wide angle
lenses because wide angles have a much greater chance of catching stray light from the side. When that stray light enters the lens it bounces around and increases flare and discoloration and also affects sharpness and contrast.

Lens Caps - Caps are the most important accessory. Protect your lens from damage.

Lens Filters - Filters allow you to creatively control the light entering your lens.
Please see Filters.

Teleconverters - Teleconverters fit between the lens and camera. They magnify the entire image. 1.4X, 2X and 3x are popular sizes. Place a 2x teleconverter on a 200mm lens and it becomes 400mm. Sounds great, but along with the extra magnification teleconverters reduce exposure. Typically, a teleconverter's light loss is directly related to it's magnification strength. A 1.4X reduces light by 1.4 stops. A 2X reduces light by 2 stops and a 3X reduces light by 3 stops. Teleconverters are most useful for lunar, solar and wildlife photography.

Extension Tubes - Extension tubes are for macro use only. They are hollow tubes that change the focusing distance of the lens allowing the lens to focus much closer to the object than normal. They come in various lengths. Longer lengths allow you to focus closer than short lengths. They can be combined for greater effect but they also cause light loss.

Reverse Ring - Reverse rings are for macro use only and fit to the front of your lens like a filter. They have a lens mount which faces out. This allows you to turn the lens around and mount it backwards. Doing this allows the lens to work at extremely close distances from the subject. Focus control is absent and the quality is similar to close up filters.

Lens Mount Adapters - Ever wanted to use a Contax Lens on a Canon body? It's physically impossible unless you use a lens mount adapter.