
Exposures, ISO's, Apertures and Shutter Speeds, Oh My!

An introduction to Exposure, the foundation for the Art of Photography.

This is the very first in a series of articles on Photography Basics. Although this is not the final article on Exposure, ISO, Aperture and Shutter Speed, I would like readers to understand at least the basic principles of exposure before getting into lengthy discussions on the Principles of the Art and Science of Photography. I'll try to explain 'Exposure', and then you can use this information to do further studying on your own.

I usually recommend to someone that asks basic questions on photography, to buy a book that covers most topics you'll need to understand. You can then use the book to guide you along. Even a cheap used book works well because you can use the book as a reference and guide to do more research on the Internet. Some people suggest just using the Internet as a free source, but then you would not have a structured framework to learn with.

Exposure is defined as such, "In photography, exposure is the total amount of light allowed to fall on the photographic medium (photographic film in a film camera or the image sensor in a digital camera) during the process of taking a photograph.¹"

What we are concerned about here is Exposure with your digital camera, which simply means how bright or how dark, your final image will be.

The four factors that determine exposure are the following:

1 - Available light

This you have no control over in most settings. It is possible to add light or use a flash, which would increase the available light, but for this discussion we will only refer to "natural available light". It may be a grey day or a sunny day or you may be in the shade... the lighting always varies.



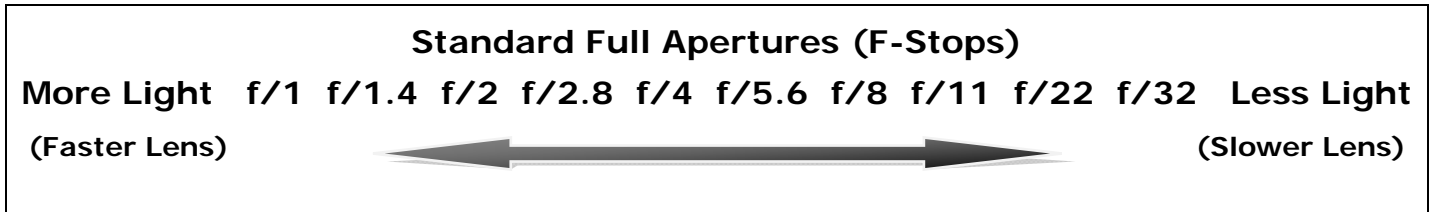
This 'hole' is actually called the Aperture and it is measured in F-Stops. This is where it can get confusing. The logic here is simple, the bigger the hole, the more light comes into the camera. Simple. However, the F-Stop numbering system works backwards because of the formula. So, f/1.4 is a big hole (more light) and f/22 is a small hole (less light).

f/1.4	f/2.0	f/2.8	f/4.0
f/5.6	f/8.0	f/11	f/16

Tip: If you think of the numbers as fractions, i.e. 1/1.4 versus 1/16, you will remember which opening is larger or smaller.

Here is a scale of Apertures (Diagram B) - Starting with the largest “Aperture” on the left, so the most light to the least amount of light on the right.

(Diagram B)



Lenses with large apertures (small F-Stops) are considered “fast” lenses because they allow more light into the sensor which allows for the use of faster shutter speeds. Lens apertures are fixed in numbers and so are limited. Typically, a lens will be f/2.8 to perhaps f/22 which would give you a total of only six full usable F-Stops.

Note: Each F-Stop lets in twice (or half) as much light as the next full F-Stop. Remember that.

So, using the aperture or “F-Stops” you can control how much light comes into the camera. The F-Stops also control what is called Depth-Of-Field. I will save discussing this Depth-Of-Field thing which is not related to exposure until another day.

What adds to the confusion here is that when someone talks about “aperture”, are they talking about the “hole size” (the aperture) or the “aperture number” (the F-Stop Number)?

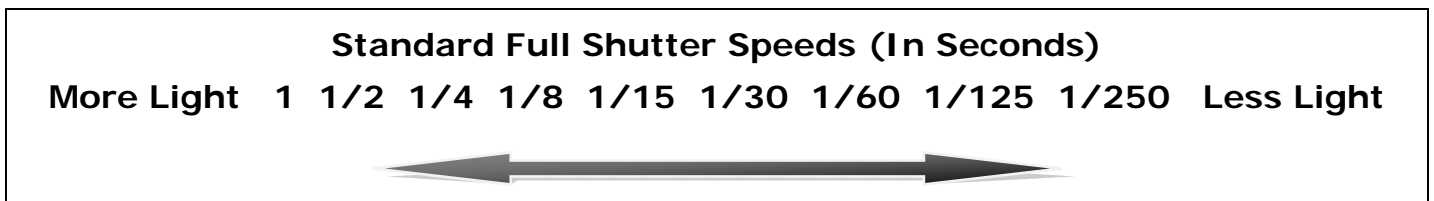
One give away is the term “lower” and “smaller”. A lower aperture is a reference to the F-Stop number. A ‘smaller’ aperture is a reference to the aperture or size of the hole unless they specify a “smaller F-Stop”. But, if they say “bigger”, you would not know what they were talking about. They could be talking about a bigger hole or bigger F-Stop number? When discussing aperture it is very important to state what parameter you are discussing. Photographers should always state the parameter, a “bigger opening”, a “bigger aperture” or a “smaller F-Stop”, all three of which allow more light into the camera.

4 - Shutter Speed

Shutter speed is measured in seconds and it controls how long the camera's sensor is exposed to light. Shutter speed is also a very simple concept. Unlike the inverse results of the F-Stop number vs. the size of the aperture, shutter speeds are easy to understand. 1 second, 2 seconds and so on, these would be considered long exposures. On the shorter side you would have 1/60th of a second, 1/125th of a second and so on.

Here is a shutter speed scale in seconds – starting with the slowest shutter speed (allows the most amount of light into the camera) to the fastest shutter speed (left to right).

(Diagram D)



Note: Each shutter speed allows twice as much light as the next number. Remember that also!

In the end, this also controls how much light goes into the camera just like an aperture, but in this case it is based on time. This “time setting” or shutter speed can determine if a photo is blurry or not. If you used a 5 second exposure, could you sit perfectly still for 5 full seconds?? This blur caused by you moving the camera is called camera shake. Your shutter speed also controls "motion blur" or rather blur caused by moving objects.

Earlier I mentioned that there are about six usable full F-Stops. The usable shutter speeds for hand held photography ranges from about 1/30th of a second to about 1/1000 of a second which also yields about six settings. This can be increased with the use of a tripod with extended shutter speeds of 1/15th of a second, 1/8th of a second and so on to exposures as long as 15 minutes or more.

Back to Exposure

So given a specific scene, say a house sparrow on a branch. Based on

- 1) the available light and
- 2) the sensitivity of the sensor (ISO 200 for this example)

your camera would automatically calculate the correct exposure settings (the aperture and shutter speed to use to get a properly exposed photo).



To calculate this exposure, your camera doesn't know it's looking at a bird on a branch, but rather thinks it is looking at a whole scene that is perfectly 18% gray¹. Why 18% gray? Why not 20% gray...or 15% gray? Because it has been determined that if the light in an average scene is averaged out, it will produce an 18% gray tone. So film - color and B/W - is formulated to produce proper exposure when it is exposed to produce an 18% gray tone.

So, for this example let's say the camera suggests using an F-Stop of f/8 and a shutter speed of 1/125th of a second. Those are the settings you would need to use to get a correct exposure or a "properly exposed photograph". Not too light and not too dark.

This leaves you two controls. You could leave the shutter speed at 1/125th second and change the aperture. Changing the aperture to f/4, a bigger hole would let in more light and would lighten your photo. An aperture of f/11 or f/16 would make the hole smaller and would let in less light making your photo darker.

Conversely, leaving the aperture at f/8 and changing the shutter speed, you could darken the picture by using a faster shutter speed (less light) or brighten it by using a slower shutter speed (more light).

Total Control

This is where the fun comes in and where you as the photographer and artist can control what is going on. Remember I suggested that the aperture controls the Depth-Of-Field and that the shutter speed can control "motion blur"? Well, the camera lets you change aperture and shutter speed settings while ALWAYS making things perfectly exposed by compensating the exposure with equivalent changes in apertures, shutter speeds or ISO's.

Back to our example. If f/8 at 1/125th of a second is a correct exposure, then we could keep the exposure (the total amount of light going into the camera) the same by changing the shutter speed higher or lower, and then adjusting the Aperture to make sure we have the same amount of light in the end.

Note: What is nice is that full F-Stops and full shutter speeds each allow half as much (or twice as much) light as previous or next numbers. (You remembered this right?) Because every exposure setting, aperture, shutter speed and ISO work in factors of 1/2 or 2, it makes it very easy to make changes to one setting and then to compensate the exposure with another setting.

This Table below shows a correct exposure of f/8 and 1/125th of a second in gray. Using any combination from any column would result in the same exposure.

(Diagram E)

Aperture	2.8	4	5.6	8	11	16	22
Shutter Speed	1/1000	1/500	1/250	1/125	1/60	1/30	1/15

So with our example of f/8 at 1/125th of a second, we could change the settings to f/5.6 (twice as much light) and to 1/250th of a second (half as much light) and still have a perfectly exposed scene (or bird in this case). By making aperture changes and then appropriate corresponding shutter speed changes to keep the exposure correct you can control the apertures and shutter speeds you want so you have full creative control of photographic elements such as focus, blur, Depth-Of-Field, bokeh, panning, lighting levels and so on.

To further control the light you could also change your ISO settings higher or lower. ISO settings are also in Full Stops and so an ISO of 200 allows twice as much light as ISO 100. Again though remember that higher ISO's create more noise and can adversely affect the quality of your images.

This then lays the foundation for the Art of Photography.

Technical Foot Notes:

¹ Exposure is measured in Lux Seconds and can be computed from Exposure Value (EV) and Scene Luminance.

² Modern day digital camera sensors and light meters are factory calibrated using ANSI luminance standards that are roughly equivalent to the reflectance of 12% gray. This is roughly half a stop off of 18%.

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