

Understanding exposure

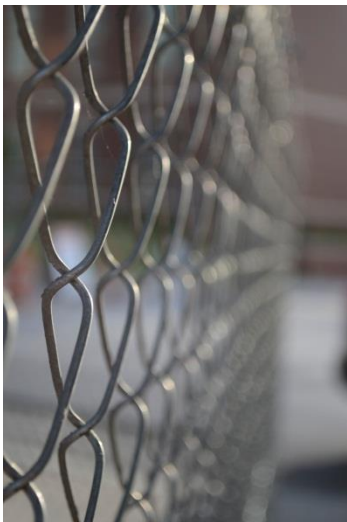
There are three elements of every photograph: composition, exposure and lighting. Composition refers to the arrangement of objects being photographed, exposure to the amount of light that is allowed to reach the film or CCD (digital light sensor), and lighting to the direction and type of light that is producing the image.

Exposure

Photography is (literally) “writing with light”, the process of allowing focused light to fall onto a light-sensitive surface. Originally this was a chemical emulsion that could be spread onto glass plates or celluloid film, but now is generally the CCD (Charge-Coupled Device) of a digital camera. Exposure refers to the amount of light that is allowed to strike the surface, which is controlled by two things: the aperture of the lens and the shutter speed. (The sensitivity of the sensor or film is also important.)

Aperture refers to the size of the hole through which light passes into the camera. The aperture is very much like a faucet, in that the more open it is, the more it allows things to pass through it. More open = more light. Less open = less light.

Aperture also affects another important element of photography: depth of field. Depth of field is the distance from the closest object that is in focus to the farthest object that is in focus. The rule here is that the wider the aperture, the smaller the depth of field. Look at the two pictures below:



Aperture: f/5.6



Aperture: f/22

The picture on the left, taken with an open aperture, has the elements closest to the camera in focus, but they rapidly go out of focus; it has a *shallow* depth of field. The image on the right, taken at f/22, has

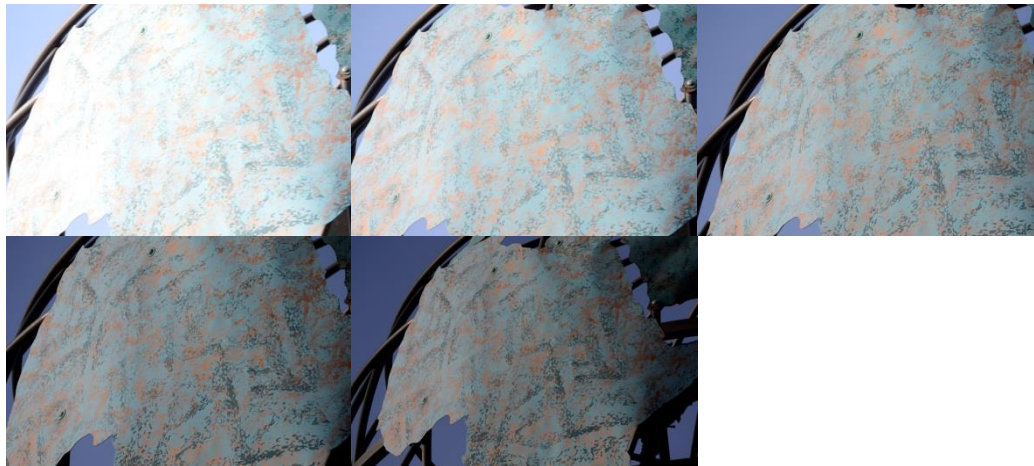
a *deep* depth of field. Depth of field is a concern for composition, but since it also affects exposure it must be considered. Focal length of the lens also affects depth of field; the longer the focal length, the shallower the depth of field.

Aperture is measured in f-stops, which are a representation of how large the aperture is compared to the focal length of the lens. They are named according to the ratio of the two numbers, and thus will usually go 1, 1.8, 2, 2.8, 4, 5.6, 8, 11, 16, 22. (Some DSLR cameras have f-stops as high as 40!) Exactly how they are calculated isn't really important to us, but it is important to remember two things: first, that the larger the number, the smaller the aperture, (so f/5.6 allows more light than f/11) and that each f-stop allows twice as much light as the next smaller one. That is, opening your aperture from f/5.6 to f/4 allows in twice as much light; closing down to f/11 allows in only $\frac{1}{4}$ as much. (One half of one half.)

Adjusting the aperture is only one way to affect the exposure, though. Another factor is the length of time the shutter is open. The shutter is a small, opaque screen in the camera with a slit in it, which moves across the CCD, quickly exposing it to light; the amount of light is proportional to the amount of time the shutter remains open. Shutter speeds may range from $\frac{1}{4000}$ of a second up to several seconds. On DSLR cameras it is usually possible to lock the shutter open to make exposures that last as long as you like.

Shutter speed also effects how pictures of moving things turn out; if the shutter speed is fast, motion tends to be frozen, whereas slow shutter speeds will allow blur from objects moving while the shutter is open.

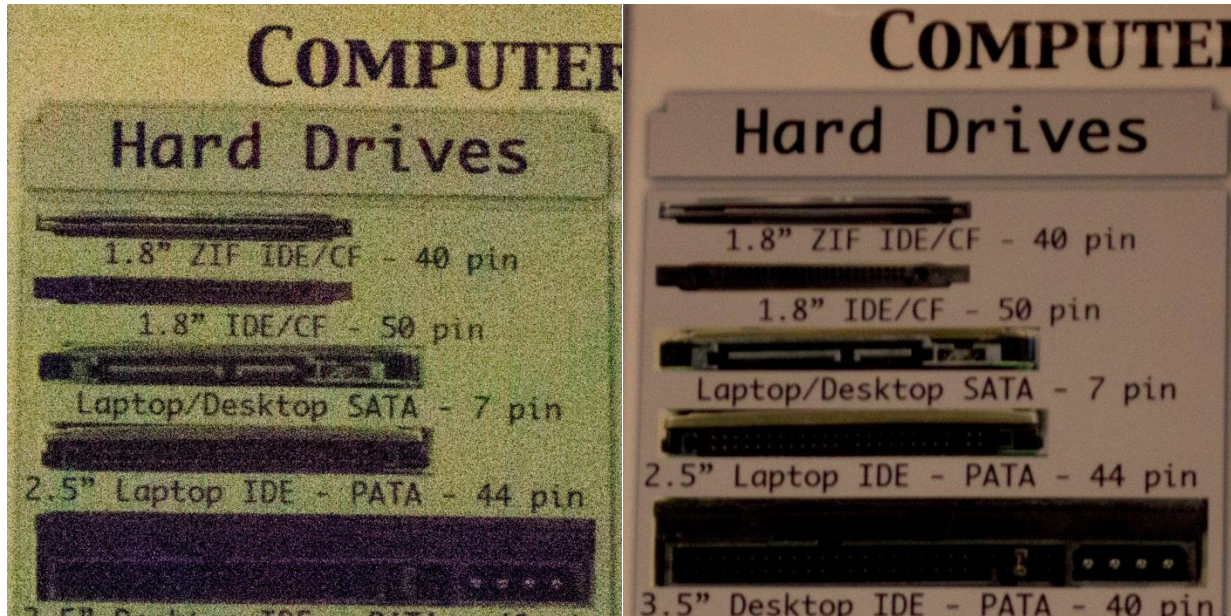
Here's an example of how shutter speed can affect exposure. Look at the sequence of pictures below:



All of these were taken at f/11, but the shutter speeds were $\frac{1}{60}$ th of a second, $\frac{1}{125}$ th, $\frac{1}{250}$ th, $\frac{1}{400}$ th and $\frac{1}{500}$ th.

The last thing that effects the exposure is the sensitivity of the film or CCD. This is measured in ISO numbers, ranging from ISO 25 to ISO 3200 or higher, with higher numbers being more light-sensitive; the nice thing about digital cameras is that it's possible to change this at any time, so if you need more light, you can just bump up the ISO.

This is, sadly, only true for a small range of ISOs. As the ISO increases, more digital noise shows up on the picture; above about ISO 800, it may make the picture essentially useless. Look at the examples:



The picture on the left was shot at ISO 12,800, the one on the right at 400. The one on the left has some color distortion and is much grainier; this is what happens when the ISO gets pushed too high.

Settings

How much control you have over these settings will depend on what sort of camera you have; a phone camera will probably give you little to no control, a DSLR should let you adjust all of them, and point-and-shoot digital cameras will vary. On a DSLR, the aperture is generally set with the thumbwheel control while in manual or aperture priority mode. For many point-and-shoot cameras, the aperture is controlled by the various modes: portrait mode will have a wide-open aperture, landscape mode will be closed, and other modes will vary. There may not be a lot of variation in those modes, however, as many small digital cameras have lenses with an aperture range of only 3-4 stops.

To determine the proper exposure for your picture, you have a couple of options: one, you can set the camera to "Auto" mode. In this mode, the camera decides for you what the aperture, ISO and shutter speed will be. You'll get a picture with decent exposure (usually) but you'll have no control over the depth of field; nor will you be able to use shutter speed creatively. Two, you can shoot in one of the preset modes or go full manual. Going manual is the best choice, but here's a quick explanation of the others:

Aperture priority (A): This allows you to set the aperture and ISO and then the camera will select the proper shutter speed. This lets you decide what depth of field you'd like and adjust sensitivity to do things like silhouette objects, and then exposes the picture appropriately. The portrait and landscape modes are variations of this, in that they set an aperture and then adjust exposure for that aperture.

Shutter priority (S): This allows you to set a shutter speed and (sometimes) the ISO. The camera then adjusts aperture (and sometimes) ISO to expose the picture. This is mainly useful if you're shooting things that are moving very fast and you don't care about depth of field. Sports mode is a variation of this; it sets a fast shutter speed for you to capture quick-moving action.

Program (P): This mode sets both shutter speed and aperture but gives limited adjustments to them. It's not very useful in general.

Manual (M): In this mode, the photographer has full control of the exposure settings. The upside is that you can control everything to get the picture you want. The downside is that it is very easy to get caught up in adjusting all the settings and forget to compose your pictures.

Sunny 16 rule

For DSLRs, it is possible to use the "Sunny 16" rule as a basis for exposure. On a bright sunny day, with the aperture at f/16, shutter speed should be the reciprocal of the ISO setting. So, if the ISO is at 100, then shutter speed should be $1/100^{\text{th}}$ or $1/125^{\text{th}}$ of a second. (Some cameras don't do $1/100^{\text{th}}$.) For ISO 200, it should be at $1/200^{\text{th}}$ of a second, and so on.

The best way to figure out exposure is practice. Understand the concepts, particularly the relationship of aperture and shutter speed to exposure, shutter speed to motion, and aperture to depth of field, and then take lots of pictures. Make sure to look at them on the computer rather than just on the camera, in order to be able to see details that may not be visible on a small screen.