SHUTTER SPEED, ISO, APERTURE

What is exposure? Exposure is a combination of 3 factors which determine the amount of light which enters your camera. These factors are aperture, ISO, and shutter speed. Photography is all about light, and without an ample amount of light entering your camera, you have nothing but a dark worthless picture. Learning how to determine the right combination of these three settings can be a tedious task, but understanding what they do will make it much easier.

Shutter Speed
Shutter speed is simply how long your camera’s shutter stays open when you take a picture. These speeds can range from thousandths of a second to 30 or more seconds. The longer your shutter stays open, the more light your camera lets in. A shutter speed of 1 second lets in 4 times the light of a shutter speed of 1/4 second. The shutter speed can also determine the clarity of a picture. A longer shutter speed will blur the shot, and create trails from even the slightest bit of movement in your picture, whereas a shorter shutter speed will 'freeze' any action and create a sharp picture in which time appears to be stopped. For an example, take a picture of a constant drip of water using both a fast and a slow shutter speed. The shot taken with the slow shutter speed will create a soft blur of water, whereas the shot taken with the faster shutter speed will catch every individual drop in mid-air.

A fast shutter speed can also help eliminate blur due to camera shake when not using a tripod.

Aperture (f/stop)
Aperture (also known as f/stop) is how large the iris (or eye) of your lens opens up. A larger aperture means a larger opening in your lens for light to pass through. When referring to aperture, a smaller number is always a larger opening. For example, an aperture of f/5.6 is a larger opening, and therefore lets more light in, than an aperture of f/11. Each unit of measurement in aperture is called a ‘stop’ one stop up would be making the lens opening larger, and one stop down would be making it smaller. A single stop down of aperture lets half the light in that the previous stop did.

Comparison of the diameter of different f/stops.
Adjusting aperture also changes your Depth of Field. Depth of field is how much of the area, measuring away from your camera, is in focus. If you are tightly focused on an object which is relatively flat, you have short depth of field. If you are focused on a group of people standing at varying distances, you would need a long (or large) depth of field. Basically, a short depth of field (which would be caused by a large aperture) will be clearly focused on a relatively shallow area. The item you focus on may be sharp and clear, but any objects in the foreground or background may be blurred. A smaller aperture would create a larger depth of field, and bring all objects into perfect focus.
Film Speed (ISO)
Film speed (or ISO) is a measurement of how sensitive your camera's sensor (or in the case of a film camera, your camera's film) is to light. The larger the ISO (higher number), the more sensitive it is to light. The smaller the ISO (smaller number), the less sensitive it is to light. Each step up in ISO doubles the amount of light sensitivity (ISO 400 is 2x as sensitive to light as ISO 200). Using a higher ISO, you can sometimes get shots in low light that would have required a longer shutter speed or a larger aperture if you were using a lower ISO. However, this does not come without its setbacks. The higher the ISO is set, the grainier your picture will appear. At higher ISOs, you will notice some extremely substantial grain. ISO noise is much less noticeable in DSLR and other large sensor cameras than it is in point and shoot cameras.

Below are some general ISO guidelines that you can follow.

100 ISO - Less grainy, good for shots with plenty of light.
200 ISO - Still not very grainy, don't need as much light as ISO 100. Grain will be more noticeable when printed in larger formats.
400 ISO - Mainly used for shooting lower-light outdoors or indoors without a flash, but with an ample amount of light. Slightly more grainy than ISO 200, but not by much.
800 ISO - Very grainy, but will give 8x the light sensitivity of ISO 100.
**EXAMPLE 1**

<table>
<thead>
<tr>
<th>Shutter Speed in seconds</th>
<th>Aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>f 1.4 f 2 f 2.8 f 4 f 5.6 f 8 f 11 f 16 f 22</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Exposure - Shutter Speed vs Aperture
Daylight - ISO 100

**EXAMPLE 2**

<table>
<thead>
<tr>
<th>Shutter Speed in seconds</th>
<th>Aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>f 1.4 f 2 f 2.8 f 4 f 5.6 f 8 f 11 f 16 f 22</td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>4</td>
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<tr>
<td>8</td>
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</tbody>
</table>

Exposure - Shutter Speed vs Aperture
Open Shade/Overcast ISO 100
CAMERA EXPOSURE
Four things that deal with light in your camera

#1 - FILM SPEED

Your camera uses film or a sensor chip to record an image. This film or chip is sensitive to light. The amount of light sensitivity is referred to as ‘film speed’ or ‘light sensitivity’. An International numbering system called ‘ISO’ was developed to represent how sensitive the film or chip is to light.

Three things to know:
1. The larger the number of the ISO the more sensitive it is to light
2. The larger the number of the ISO it is called a ‘faster’ film speed
3. The larger the number of the ISO the grainier the image.

<table>
<thead>
<tr>
<th>Film Speed / ISO</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ISO</td>
<td>Less grainy. When image is enlarged, it looks nice and smooth. Great for weddings, etc. if you have plenty of light.</td>
<td>Less sensitive to light so you will need more light to get a properly exposed image.</td>
</tr>
<tr>
<td>200 ISO</td>
<td>Still not very grainy and it is more sensitive to light so you don’t need as much light to get a properly exposed image.</td>
<td>Slightly more grainy than 100 ISO. You will slightly notice this if you enlarge it to an 8X10” print.</td>
</tr>
<tr>
<td>*note- this is twice as sensitive to light as 100 ISO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400 ISO</td>
<td>Often used for shooting outdoor sports or indoors without a flash (as long as the room is well lit).</td>
<td>Slightly more grainy than 200 ISO. It use to be a lot more grainy, but they’ve made improvements</td>
</tr>
<tr>
<td>*note- this is 4 times more sensitive to light as 100 ISO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 ISO</td>
<td>Even better for shooting sports. It is a ‘faster’ speed which allows you to ‘freeze frame’ action. Great for low light photography when you can’t use a flash.</td>
<td>If you enlarge it to an 8X10” print or more, it will obviously be speckled and grainy. The color will not be as lush as 100 ISO.</td>
</tr>
<tr>
<td>*note- you guessed it, it is 8 times more sensitive to light than 100 ISO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#2 - BUILT-IN LIGHT METER

Your camera has a built-in light meter that measures how much light is touching your film or sensor chip. It measures the light reflecting through your lens and averages it together to come up with a proper exposure. If you have a camera with fully automatic features, you may not even be aware of
your light meter because it ignores you and just tells your camera what to do. All you have to do is point and shoot. However in some instances the light will fool your meter (such as when your subject is in the snow or water) and you will need to make adjustments to get a properly exposed picture.

Some light meters can be set to average all the light coming in from the lens, or be more sensitive to light coming in from certain spot in your frame. Your camera might call it Spot or Matrix metering. Don't worry about that for now and just use the default light metering system.

**Important:** Your light meter bases its exposure on whatever your ISO setting is. If you have a film camera be sure your ISO on your camera is set to match the ISO of your film otherwise your pictures will not be exposed properly.

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### #3 – APERTURE

Aperture controls two things:

1. The amount of light being exposed on your film or chip
2. Depth of field

**The Amount of Light**

Aperture is the small hole behind your lens that can be adjusted in size to let in different amounts of light into your camera. It works similar to the iris of your eye.

Another name for aperture is ‘f-stops’. The size of the hole is measured in fractions. A small hole might be \( \frac{1}{22} \) of an inch in size. In photo language they would replace the 1 with an ‘f’ and call it \( f/22 \). To simplify they might just call that particular aperture size, ‘22’. This confuses people at first because it seems like they are using a larger number to refer to a small hole. **Just remember that this number is a fraction and refers to a smaller sized opening.**

**Depth of Field**

When you focus on a subject, it will be sharp and clear no matter what your aperture is. The amount of things that **appear** to be sharp and clear in front and behind your point of focus, is your **depth of field**

If you have a small opening (aperture), say \( f/22 \), this will allow less light to touch your film or chip AND will give you greater depth of field. In other words whatever your camera is focused on, things in front of it and behind it will appear to be in focus also. (Think of it as how you might squint your eyes when you want to see something better. The smaller you make your opening to your eyes (lens), the more things appear to be in focus.)

Now remember that I said \( f/22 \) allows less light to touch your film or chip? If you didn’t make an adjustment for light, your image will not be properly exposed. This is where your shutter speed comes in. In order to adjust for a dimmer amount of light coming in from your aperture, you need to give a longer exposure using your shutter speed.

**Important:**

Aperture and Shutter speed both control the amount of light reaching your film or chip. They are like spoiled children. Whatever is done to one affects the other. If you adjust
one, the other needs to be adjusted to compensate. If not they have a tirade and won’t give you a properly exposed image.

**Rule of Thumb:**
- A larger opening, say an aperture of f/1.4 will allow more light in and give you less depth of field (less things in focus)
- A smaller opening, say an aperture of f/22 will allow less light in and give you greater depth of field (more things in focus)

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**#4 - SHUTTER SPEED**

Shutter speed controls two things:
1. Amount of light being exposed on your film or chip
2. Motion

**Amount of Light**

In front of your film is a shutter that is closed (keeping out light) until you press the shutter release on your camera. When you press the shutter release, the shutter will open up for a period of time allowing light onto your film. It can be set for different speeds of exposure, which is also represented in fractions. Instead of measuring fractions of size, as in apertures, it measures fraction of time. For instance 1/60 represents an exposure of 60th of a second.

The slower the exposure time, the more time you have to expose light onto your film or chip. Remember this works hand in hand with your aperture. If you have a small aperture it will not be letting in much light so you will need a longer exposure using your shutter speed. Conversely if you have a large aperture, which lets in lots of light, you may need a faster shutter speed which allows less time for the light to touch your film so it won’t be overexposed.

**Motion**

Since your shutter speed is based on the amount of time your film or chip is exposed to light, it makes sense that time will also effect motion.

For instance, anything that moves during the period of time your film is being exposed, will be recorded. If you have a slow shutter speed, something may have moved from one side of your frame to the other side while your film/chip was being exposed. This would create a blurry image.

Conversely, if you had a fast shutter speed, your exposure might be so fast that the shutter closed before the subject could move anywhere. This would create a ‘freeze-frame’ or ‘stopped action’ image.

**Important:**

Remember again, Shutter speed and Aperture both control the amount of light reaching your film or chip. If you adjust one, the other needs to be adjusted to compensate. If not they won’t give you a properly exposed image.
Rule of Thumb:

- A fast shutter speed freezes motion
- A slow shutter speed blurs motion
Shutter Speeds, f-stops (Depth of Field) and Camera Meters: A Quick Primer

In better film and digital cameras, you can adjust shutter speeds and f-stops. Adjustment of these two variables can result in wonderful creative effects. Knowledge of these settings empowers you as a photographer.

All photography is a compromise. You are balancing time (shutter speed) versus quantity of light (aperture/opening of your lens). Think of a faucet: You can turn it on full blast and fill a cup of water in five seconds. Think of "full blast" as a lens that is all the way open at a setting such as 2.8. If you turn the faucet half on (your lens is letting half as much light, at a setting such as 4.0), only half the water (light) is coming in, so to fill the glass you'll have to leave the faucet on twice as long. This length of time is the shutter speed.

Shutter Speeds

Typically, shutter speeds vary from a short 1/1000 of a second (which freezes action in sports photography) on down to slower speeds such as 1/500, 1/250 (still okay for action photography), 1/125, 1/60, 1/30 (this last is marginal for hand-holding), 1/15, 1/8, 1/4, 1/2, 1 second and "B" which stands for "bulb," a now-outmoded photographic technique, which in real life means you use a cable release (a device that means you trip the shutter remotely with a cord so your shaky hands don't touch the camera and cause blur) and manually hold it down for a certain number of seconds or lock the cable release for extensive exposures such as astronomy photography. Use longer shutter speeds with a tripod for "impressionistic" photos or "silky" photos of waterfalls. The faster the shutter speed, the less light comes into the camera. On older cameras, each shutter speed is twice or half of its adjacent shutter speed. Most newer cameras feature increments between these settings, usually 1/3 or 1/4 the setting above or below it.

f-stops (Depth of Field)

Your other creative camera control is the aperture (opening) on your lens. We measure the size of the opening using f-stops. Each f-stop is twice as large or half as small as the one next to it. Thus, when you set your lens at f/8, and then adjust the lens to f/11, you're letting in half as much light. Conversely, if you set your lens at f/8 and then adjust it to f/5.6, you're letting in twice as much light. On a 35mm camera, you'll find f-stop settings like f/1 (wide open), f/1.4, f/2.8, f/3.5, f/4.0, f/5.6, f/8, f/11, f/16, f/22, f/32. To gain a bit of light, you'll also see non-standard apertures such as f/1.8, f/3.5 or f/4.5.

Why bother with all this? As you go higher in f-stop numbers, you increase the front-to-back distance (depth of field) in your photograph. Thus, if you take a
picture at f/22 (a very small opening), you’ll have most of your picture in focus. A way to remember this is as you go higher in f-numbers, more of the picture is in focus.

Another factor to keep in mind is that your depth of field decreases as your camera/subject distance decreases. Thus depth-of-field becomes a major challenge in close-up photography. Depth of field also decreases when you use medium or large format equipment, such as equipment that uses 120/220 or 4"x5" film. Depth of field decreases, too, when you use telephoto lenses.

Going back to our faucet analogy, the challenge with increased f-number (smaller aperture) is that less light comes in through the lens. So you must compensate with a slower shutter speed. And hence we have problems like camera shake and fuzzy photos. The choice of apertures and shutter speeds is yours.

Most of the time you will be safe in using mid-range camera settings. In sunny mid-day conditions, you can use an f-stop of f/8 and 1/250 of a second and do just fine with ISO 100 film. Automatic and inexpensive box cameras and many digital cameras are preset to such aperture/shutter speed combinations.

Many newer cameras allow you to set them to either shutter-priority or aperture-priority modes. Typically, use shutter-priority for sports or action photography to ensure high shutter speeds with telephoto lenses. Use aperture-priority for landscapes.

Many cameras (especially older, manual models) have a feature called depth of field preview. Since nearly all lenses nowadays are automatic, meaning that you view your image at the wide-open setting until you take the photo, when the lens stops down to your desired aperture, you can’t see how much of your image is in focus. When you press the depth-of-field preview button, the image will appear darker, depending on the f/stop you’ve chosen. But you will be able to see how much of your image is sharp. Older camera lenses--sadly, a rarity these days--also have depth of field markings on the lens barrels.

Film Speeds

Film "speeds" vary according to the sensitivity of the chemicals in the film. Films with bigger ISO numbers (such as 400) are more sensitive to light, so they’re great when you work with low-light photographic situations or you have to do sports photography. However, such films aren't as high-quality as lower ISO films, such as films with an ISO of 64 or 100. Digital follows a similar pattern. So there's a trade-off.

On some cameras you must manually set the ISO for whatever film you have in the camera, usually with a dial on the top of the camera (either right or left side). Newer automatic cameras and many point-and-shoots read a pattern off the film.
cannister, called the DX coding. On digital cameras, you either set this feature through your LCD menu or through separate command dials on the camera body.

**Camera Meters**

Camera meters are stupid, with one simple job to do. Using center-weighted needles or LED readouts, they work to make your picture fit a middle gray tone (we call this 18% gray, based on reflectance of a universally calibrated card). In the case of color, those middle tones may be beige, flesh, green, etc.

Most of the time this system works. In the case of print film, there's a lot of room (5 stops each way for Kodacolor) for error. The machine that processes film negatives at your local drugstore will adjust for exposure errors, trying (again) to make everything a middle gray tone, as most of the time snapshotters don't want their photos to be too light or dark. But there are a lot of special situations. If you're taking a picture of your kid skiing down a snowy slope, the camera meter will want to make the whole scene gray, and the snow will come out gray, with your child as a silhouette. In such situations, take a meter reading from a neutral source (or if you want to get fancy, use a spot meter, which reads a tiny fraction of your scene, such as that found in a one-degree or five-degree arc), and use that reading for your photograph, in spite of what your meter says. If your print photo is special and you don't like the darkness or lightness what you get back from the drugstore, a custom lab will print a better-exposed print for you, though keep in mind because of the handwork, this can be costly.

Digital cameras act in much the same way, trying to average out the exposures so that everything in the photo is a mid-tone.

If you have to make an exposure in a difficult lighting situation, try these "ball-park" neutral sources: Meter off grass. Or, on a sunny day, try metering off the north sky at the horizon line. You can also meter off the back of your hand (light skin) and then "open up" one stop (e.g., your meter says f/8, so you go to f/5.6). With most automatic cameras--digital or film--you will have to find a way to lock in the exposure. Consult your manual for ways to do this.

Backlighting (where the primary source of light comes from behind the subject) provides another challenge. Some so-called automatic cameras have special settings for backlighting. But in general use your brain: you can generally allow two more f-stops than what your camera meter says. Or meter off a similar front-lit subject and then use those settings. When in doubt, bracket: take a meter reading according to what your meter says, then take a photo that is a half-stop or stop over-exposed and another that is a half-stop or full stop under-exposed. Often, "correct" exposure is a matter of personal preference.

**Digital Histogram**

Higher-end digital cameras have a valuable tool called the histogram. This will
look like a white mountain (or sometimes, several white mountains) in your menu (consult your manual on how to access this feature). If the mountain is spilling off the histogram to the left, your exposure is too dark. Conversely, if it spills to the right, your exposure is too bright. This is an excellent feature for double-checking your exposure in the field.

**Camera Meter Broken (or you don't trust it or want to double-check it)**

You can try the "Sunny 16" rule. This means that you should be able to get okay pictures if, on a sunny day, you set your aperture to f/16 and your shutter speed closest to whatever ISO you're using. For example, if you're using ISO 100 film, set your aperture to f/16 and your shutter speed to 1/125 (which is closest to ISO 100).

Meters can vary from one camera to the next and are often one of the first things to malfunction in a camera. Sometimes the meter is all right, but your shutter speeds are erratic (this is especially true in older manual cameras that have been stored for a long time; a reliable camera repair shop can recalibrate your shutter speeds for you.) Check your meter against the settings recommended in this section. If you find you're consistently getting incorrect exposures you can compensate by slightly adjusting your ISO setting.

You can use creative controls by varying your apertures/shutter speeds. The inside of your film box or a separate sheet packaged with the film will give you recommended settings for common photo situations. If you have an erratic camera meter, consistently use the same kind of film and begin memorizing some of the settings below so you can out-guess your meter. Here are some typical settings and their variations for **ISO 100 film** (note that higher shutter speeds apply only to certain brands of automatic cameras):

<table>
<thead>
<tr>
<th>Open Shade</th>
<th>Cloudy Bright (No Shadows)</th>
<th>Weak Hazy Sun Soft Shadows</th>
<th>Bright/Hazy Sun (Distinct Shadows)</th>
<th>Bright/Hazy Sun on Light Sand/Snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Overcast</td>
<td>f/2.8 @ 1/500 sec</td>
<td>f/2.8 @ 1/1000</td>
<td>f/2.8 @ 1/1000</td>
<td>f/4 @ 1/2000</td>
</tr>
<tr>
<td>f/4 @ 1/250</td>
<td>f/4 @ 1/500</td>
<td>f/4 @ 1/1000</td>
<td>f/4 @ 1/1000</td>
<td>f/4 @ 1/2000</td>
</tr>
<tr>
<td>f/5.6 @ 1/125</td>
<td>f/5.6 @ 1/250</td>
<td>f/5.6 @ 1/500</td>
<td>f/5.6 @ 1/1000</td>
<td>f/5.6 @ 1/2000</td>
</tr>
<tr>
<td>f/8 @ 1/60</td>
<td>f/8 @ 1/125</td>
<td>f/8 @ 1/250</td>
<td>f/8 @ 1/500</td>
<td>f/8 @ 1/1000</td>
</tr>
<tr>
<td>f/11 @ 1/30</td>
<td>f/11 @ 1/60</td>
<td>f/11 @ 1/125</td>
<td>f/11 @ 1/250</td>
<td>f/11 @ 1/500</td>
</tr>
<tr>
<td>f/16 @ 1/15</td>
<td>f/16 @ 1/30</td>
<td>f/16 @ 1/60</td>
<td>f/16 @ 1/125</td>
<td>f/16 @ 1/250</td>
</tr>
<tr>
<td>f/22 @ 1/8</td>
<td>f/22 @ 1/15</td>
<td>f/22 @ 1/30</td>
<td>f/22 @ 1/60</td>
<td>f/22 @ 1/125</td>
</tr>
</tbody>
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