CAMERA EXPOSURE

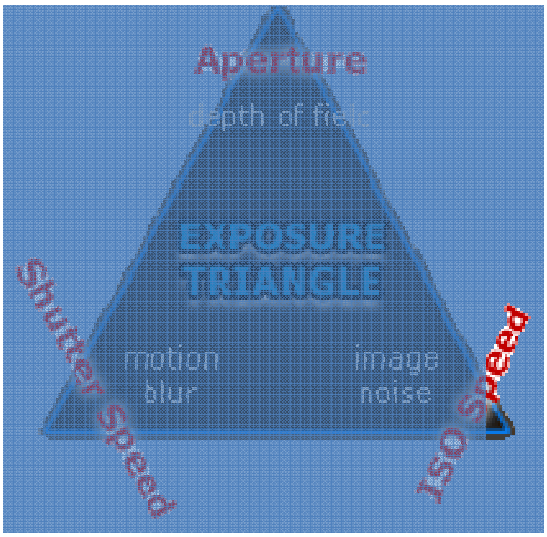
A photograph's exposure determines how light or dark an image will appear when it's been captured by your camera. Believe it or not, this is determined by just three camera settings: aperture, ISO and shutter speed (the "exposure triangle"). Mastering their use is an essential part of developing an intuition for photography.

UNDERSTANDING EXPOSURE

Achieving the correct exposure is a lot like collecting rain in a bucket. While the rate of rainfall is uncontrollable, three factors remain under your control: the bucket's width, the duration you leave it in the rain, and the quantity of rain you want to collect. You just need to ensure you don't collect too little ("underexposed"), but that you also don't collect too much ("overexposed"). The key is that there are many different combinations of width, time and quantity that will achieve this. For example, for the same quantity of water, you can get away with less time in the rain if you pick a bucket that's really wide. Alternatively, for the same duration left in the rain, a really narrow bucket can be used as long as you plan on getting by with less water.

In photography, the exposure settings of aperture, shutter speed and ISO speed are analogous to the width, time and quantity discussed above. Furthermore, just as the rate of rainfall was beyond your control above, so too is natural light for a photographer.

EXPOSURE TRIANGLE: APERTURE, ISO & SHUTTER SPEED



Each setting controls exposure differently:
Aperture: controls the area over which light can enter your camera
Shutter speed: controls the duration of the exposure
ISO speed: controls the sensitivity of your camera's sensor to a given amount of light

One can therefore use many combinations of the above three settings to achieve the same exposure. The key, however, is knowing which trade-offs to make, since each setting also influences other image properties. For example, aperture affects depth of field, shutter speed affects motion blur and ISO speed affects image noise.

The next few sections will describe how each setting is specified, what it looks like, and how a given camera exposure mode affects their combination.

SHUTTER SPEED

A camera's shutter determines when the camera sensor will be open or closed to incoming light from the camera lens. The shutter speed specifically refers to how long this light is permitted to enter the camera. "Shutter speed" and "exposure time" refer to the same concept, where a faster shutter speed means a shorter exposure time.

By the Numbers. Shutter speed's influence on exposure is perhaps the simplest of the three camera settings: it correlates exactly 1:1 with the amount of light entering the camera. For example, when the exposure time doubles the amount of light entering the camera doubles. It's also the setting that has the widest range of possibilities:

Shutter Speed	Typical Examples
1 - 30+ seconds	Specialty night and low-light photos on a tripod
2 - 1/2 second	To add a silky look to flowing water Landscape photos on a tripod for enhanced depth of field
1/2 to 1/30 second	To add motion blur to the background of a moving subject Carefully taken hand-held photos with stabilization
1/50 - 1/100 second	Typical hand-held photos without substantial zoom
1/250 - 1/500 second	To freeze everyday sports/action subject movement Hand-held photos with substantial zoom (telephoto lens)
1/1000 - 1/4000 second	To freeze extremely fast, up-close subject motion

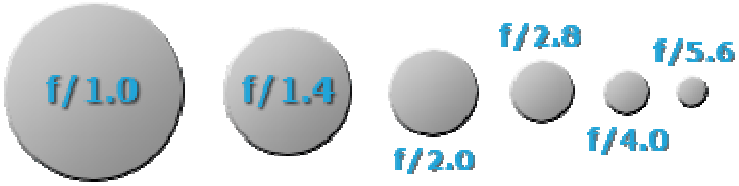
How it Appears. Shutter speed is a powerful tool for freezing or exaggerating the appearance of motion:	
	
Slow Shutter Speed	Fast Shutter Speed

With waterfalls and other creative shots, motion blur is sometimes desirable, but for most other shots this is avoided. Therefore all one usually cares about with shutter speed is whether it results in a sharp photo — either by freezing movement or because the shot can be taken hand-held without camera shake.

How do you know which shutter speed will provide a sharp hand-held shot? With digital cameras, the best way to find out is to just experiment and look at the results on your camera's rear LCD screen (at full zoom). If a properly focused photo comes out blurred, then you'll usually need to either increase the shutter speed, keep your hands steadier or use a camera tripod.

APERTURE SETTING

A camera's aperture setting controls the area over which light can pass through your camera lens. It is specified in terms an f-stop value, which can at times be counterintuitive, because the area of the opening *increases* as the f-stop *decreases*. In photographer slang, the when someone says they are "stopping down" or "opening up" their lens, they are referring to increasing and decreasing the f-stop value, respectively.



By the Numbers. Every time the f-stop value halves, the light-collecting area quadruples. There's a formula for this, but most photographers just memorize the f-stop numbers that correspond to each doubling/halving of light:

Aperture Setting	Relative Light	Example Shutter Speed
f/22	1X	16 seconds
f/16	2X	8 seconds
f/11	4X	4 seconds
f/8.0	8X	2 seconds
f/5.6	16X	1 second
f/4.0	32X	1/2 second
f/2.8	64X	1/4 second
f/2.0	128X	1/8 second
f/1.4	256X	1/15 second

The above aperture and shutter speed combinations all result in the same exposure.

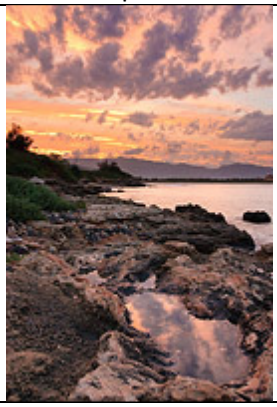
Note: Shutter speed values are not always possible in increments of exactly double or half another shutter speed, but they're always close enough that the difference is negligible.

The above f-stop numbers are all standard options in any camera, although most also allow finer adjustments, such as f/3.2 and f/6.3. The range of values may also vary from camera to camera (or lens to lens). For example, a compact camera might have an available range of f/2.8 to f/8.0, whereas a digital SLR camera might have a range of f/1.4 to f/32 with a portrait lens. A narrow aperture range usually isn't a big problem, but a greater range does provide for more creative flexibility.

Technical Note: With many lenses, their light-gathering ability is also affected by their transmission efficiency, although this is almost always much less of a factor than aperture. It's also beyond the photographer's control. Differences in transmission efficiency are typically more pronounced with extreme zoom ranges. For example,

Canon's 24-105 mm f/4L IS lens gathers perhaps ~10-40% less light at f/4 than Canon's similar 24-70 mm f/2.8L lens at f/4 (depending on the focal length).

How it Appears. A camera's aperture setting is what determines a photo's depth of field (the range of distance over which objects appear in sharp focus). Lower f-stop values correlate with a shallower depth of field:

	
Wide Aperture - f/2.0 - low f-stop number - shallow depth of field	**Narrow Aperture** f/16 - high f-stop number - large depth of field

ISO SPEED

The ISO speed determines how sensitive the camera is to incoming light. Similar to shutter speed, it also correlates 1:1 with how much the exposure increases or decreases. However, unlike aperture and shutter speed, a lower ISO speed is almost always desirable, since higher ISO speeds dramatically increase image noise. As a result, ISO speed is usually only increased from its minimum value if the desired aperture and shutter speed aren't otherwise obtainable.

 **Low ISO Speed -** (low image noise)	 **High ISO Speed -** (high image noise)

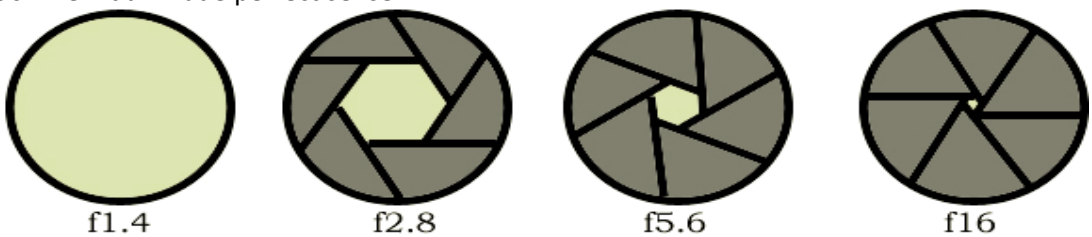
Note: image noise is also known as "film grain" in traditional film photography

Common ISO speeds include 100, 200, 400 and 800, although many cameras also permit lower or higher values. With compact cameras, an ISO speed in the range of 50-200 generally produces acceptably low image noise, whereas with digital SLR cameras, a range of 50-800 (or higher) is often acceptable.

A Beginner's Guide to Simple Photography Concepts: ISO, Aperture, and Shutter Speed

There are 3 things that affect your image quality in photography; ISO, aperture and shutter speed. All 3 of these things depend on one other factor which is light. A photograph is basically a chemical process in which light is exposed to film, or a sensor in digital cameras, and registers an image.

There's a device in the camera called the diaphragm, which is directly connected to aperture. The different aperture settings are called f-stops, and are represented by the numbers you see on the image. The larger the number, the smaller the aperture, so for example, an f-stop of f1.4 would be very large, while an f-stop of f16 would be very small. Typically, most consumer lenses have a range of f2 to f16. Don't be overwhelmed by the technical terms and numbers and things like that, once you try everything out on the actual camera, it will all start to make sense. When I first went over the module on this it was all gibberish to me, until I actually took some pictures trying all the different settings. That's when it all made perfect sense.



Now, usually a faster shutter speed will require a larger aperture to allow enough light into the camera, and a slower shutter speed will need a smaller aperture to prevent too much light from getting in. You see, shutter speed is how long the shutter is open to allow light into the camera. Shutter speed is always measured in seconds. To demonstrate the effect of ISO, see the below image. Each photo was taken at 1/250th of a second, and the aperture set to f5.6, while the ISO was changed. The ISO is simply how sensitive the film, or censor in a digital camera, is to light. The lower the ISO is, the less sensitive it is to light. The higher the ISO is, the more sensitive it is to light. You can see from the photo, that at 100 ISO, the picture is quite dark. At 400 ISO, the picture is better, and at 1600 ISO, the picture is far too bright. Depending on the ISO you are using, your shutter speed will have to be adjusted to allow

the right amount of light for what you want to achieve. The more light that is available, the faster your shutter speed can be.

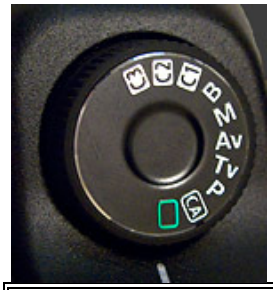
Now, let's talk a little about why shutter speed is important. It's pretty simple, actually. The faster your shutter opens and closes, the less you have to worry about a blurry image. For most people, a shutter speed of 1/60th of a second is the slowest you can hand hold the camera before experiencing blur due to camera shake. If you are photographing a still object, or a slow moving object, a fast shutter speed isn't as important. If you are photographing a fast moving object, a fast shutter speed suddenly becomes a necessity most of the time. Now remember, the higher the ISO, the more sensitive the film/censor will be to the light. So one might think it's best to always use the highest ISO possible, right? The correct answer is; sometimes. In the next image we see something new, called grain.

Grain is essentially how nice your photos look. Most of the time, you won't be able to tell the difference in grain at standard print size of 4x6. However, if you ever have a photograph you'd like to enlarge, ISO suddenly becomes very important. The higher the ISO, the grainier your photo will look. Below I cropped just the face of an image, one at 100 ISO and the other at 1600 ISO. The first photo looks smoother, while the second looks, well, grainy. Most consumers won't need to be making a lot of enlargements, so this doesn't always matter. But even an amateur will sometimes get that one perfect shot they just would love to hang on their wall. Unfortunately, if that perfect shot was taken with a high ISO film, or using a high ISO setting on a digital camera, the size of the enlargement will be limited before it starts to look bad. I find for the average every-day John and Jane Q. Normal, 400 ISO is best. It gets more complicated of course if you're looking at it from a professional level, and I may get into that another time. Finally, we get to what most people get lost on, Depth of Field. Let's start this time by looking at a picture.

Most likely, in the first frame, your eye is attracted to the figurine. This is because the back round is blurred, and unobtrusive. In the second frame still focused on the figurine, but a little distracted. In the last frame, your eye was probably drawn first to the red box, and when you look at the figurine, you're distracted by the box in the center. So as you can see from the pictures, depth of field is essentially the area in front and behind the object that is in focus.. Each photo was taken with the same ISO, but both the shutter speed and aperture were changed. As you can see, the back round became less blurred the smaller the aperture. The entire time I kept focused on the figurine. Anything in front of, or behind the figurine would appear blurry. You can set things up however so that your depth of field is infinite (to a degree) and everything is sharp. The further away something is, the more infinite the focus can be. The closer it is, the more limited that becomes. For example, if taking a macro photo of a small insect, you can have the insect in focus, but no matter what lens or camera you have, you can focus on both the insect up close and mountains in the distance. The closer something is, the more limited the depth of field will be.

Depth of Field is probably the most confusing to beginners, because reading about it can be complicated, as there are many different factors that will affect your depth of field. For example, a telephoto lens will have a more sensitive depth of field, while a wide angle lens will be less obvious. It's easiest to tackle this one factor by taking your camera out and just trying the different aperture settings and distances from objects. Some cameras will have a depth of field preview button, that will show you in the viewfinder how the depth of field will look. This is a very helpful function to have, but if not, trial and error must be used for the beginner.

The settings for all these functions will be available on most digital cameras, not just SLR's. You'll have to consult your manual for help on where to find them and how to set them on your camera.



CAMERA EXPOSURE MODES

Most digital cameras have one of the following standardized exposure modes: Auto ( ), Program (P), Aperture Priority (Av), Shutter Priority (Tv), Manual (M) and Bulb (B) mode. Av, Tv, and M are often called "creative modes" or "auto exposure (AE) modes."

Each of these modes influences how aperture, ISO and shutter speed are chosen for a given exposure. Some modes attempt to pick all three values for you, whereas others let you specify one setting and the camera picks the other two (if possible). The following charts describe how each mode pertains to exposure:

Exposure Mode	How It Works
Auto ( )	Camera automatically selects all exposure settings.
Program (P)	Camera automatically selects aperture & shutter speed; you can choose a corresponding ISO speed & exposure compensation. With some cameras, P can also act as a hybrid of the Av & Tv modes.
Aperture Priority (Av or A)	You specify the aperture & ISO; the camera's metering determines the corresponding shutter speed.
Shutter Priority (Tv or S)	You specify the shutter speed & ISO; the camera's metering determines the corresponding aperture.
Manual (M)	You specify the aperture, ISO and shutter speed — regardless of whether these values lead to a correct exposure.
Bulb (B)	Useful for exposures longer than 30 seconds. You specify the aperture and ISO; the shutter speed is determined by a remote release switch, or by the duration until you press the shutter button a second time.

In addition, the camera may also have several pre-set modes; the most common include landscape, portrait, sports and night mode. The symbols used for each mode vary slightly from camera to camera, but will likely appear similar to those below:

Exposure Mode	How It Works
Portrait	Camera tries to pick the lowest f-stop value possible for a given exposure. This ensures the shallowest possible depth of field.
Landscape	Camera tries to pick a high f-stop to ensure a large depth of field. Compact cameras also often set their focus distance to distant objects or infinity.
Sports/Action	Camera tries to achieve as fast a shutter speed as possible for a given exposure — ideally 1/250 seconds or faster. In addition to using a low f-stop, the fast shutter speed is usually achieved by increasing the ISO speed more than would otherwise be acceptable in portrait mode.
Night/Low-light	Camera permits shutter speeds which are longer than ordinarily allowed for hand-held shots, and increases the ISO speed to near its maximum available value. However, for some cameras this setting means that a flash is used for the foreground, and a long shutter speed and high ISO are used expose the background. *Check your camera's instruction manual for any unique characteristics*.

However, keep in mind that most of the above settings rely on the camera's metering system in order to know what's a proper exposure. For tricky subject matter, metering can often be fooled, so it's a good idea to also be aware of when it might go awry, and what you can do to compensate for such exposure errors (see section on exposure compensation within the camera metering tutorial).
Finally, some of the above modes may also control camera settings which are unrelated to exposure, although this varies from camera to camera. Such additional settings might include the autofocus points, metering mode and autofocus modes, amongst others.

RAW vs JPEG - Image Impact
One of the most frequently discussed questions amongst experienced photographers and those just starting out in digital photography, is whether to shoot in RAW or JPEG format with a digital SLR (dSLR) camera. Numerous articles have been written on this question, online and in various photographic magazines, yet several key discussion points are often glossed over.

The Basics:
To put everyone on the same plane of knowledge, whether you're an experienced digital photographer or someone that is just now looking into digital photography, the file formats in question should be defined.

RAW format is often a proprietary format of a particular camera make. RAW files hold all the RAW data captured by the camera. Unlike conventional photography where light is exposed against film with a specific chemical formulation to provide deep saturation or soft skin tones that would otherwise be automatically applied based on the type of film used, RAW digital files contain raw data that is uninterpreted and unaltered. RAW files in their simplest description can be thought of as digital negatives. They are a pre-production starting point.

JPEG format compresses image data into a smaller file size. In theory, a JPEG file contains less data (how much depends on the specified size and compression/quality settings) than an equivalent RAW file, but is able to closely reproduce an image once fully loaded. When saving an image with photo editing software it is possible to save an image with different levels of JPEG compression. This enables you to create files that take less storage space sacrificing how well the file displays or take up more storage space to more accurately reproduce the original image.

Know Thy Self - Key Questions To Ask Yourself
Unlike recommendations in other articles I've read, the best way to immerse yourself into this question of whether to use (capture and/or edit) RAW or JPEG file formats is to ask yourself the following questions:

"*What are your goals as a photographer?*"
Surprisingly, this is often alluded to in articles I've read on this subject, but never explicitly stated. The significance of this question is quite important, as you'll want to select the right file format to match the following: your output goals (print, online display, etc), your technical comfort level, your available storage capacity, your computer software/hardware capabilities, and the amount of time you're willing to commit to the post-production of your work.

"*How comfortable are you with editing images on a computer?*"
Many long-time photographers are technically excellent and seldom need to make substantial edits in post-production; while newer photographers just starting out in the digital format may need to employ many post-production editing features available to them to clean up their images. Realistically assessing your technical skill level behind the camera and behind a computer is a key factor in deciding what file format to use.
Format Pros & Cons:
The Pros of RAW format:

- RAW is a digital negative holding all of the data captured by your camera providing you a foundational element to which to apply all of your edits to with no sacrifice of image quality.
- RAW file software editors allow you to quickly and easily change the output of your image such as adjusting exposure, white balance, noise reduction, image size (interpolation), saturation, contrast, levels, curves, sharpness, output resolution, bits/channel, etc.
- RAW file software editors allow you to load saved adjustment settings and some even enables users to batch process a group of files versus making changes to one file at a time.

The Cons of RAW format:

- RAW files take up more space on your camera's compact flash card or microdrive than other formats.

- RAW files require you conduct some degree of post processing via photo editing software to convert your image to an editable file type for editing, printing and/or online display.
- RAW file software editors have a learning curve, even if mild, and for the uninitiated can be intimidating at first.
- Batch processing and/or loading multiple files may tax slower machines and require more computer RAM to keep your software running smoothly.

The Pros of JPEG format:

- JPEG is a file format that has been adopted as a standard and can be loaded in a variety of programs making display easy and simple.
- JPEG files take up less space on your camera's compact flash card or microdrive than other formats.
- JPEGs can be loaded easily by most all image editing software applications, requiring no intermediate steps.
- Most dSLRs enable you to choose what size JPEG files (S, M, or L) to save to your compact flash card or SD Card when shooting. This enables you to use smaller images that are easier to handle for email attachments, web display or as an alternate preview mechanism if your camera supports saving files in JPEG and RAW formats simultaneously.

The Cons of JPEG format:

- JPEGs are not a lossless file format. Each time the file is saved data is compressed, with some data being lost in the process. The net impact can be loss of color saturation, color range and sharpness.
- JPEG files reflect a one-time interpretation of your subject based on the settings of your camera (white balance, exposure settings and output resolution, etc.). Altering these settings and re-outputting a new file, as you can with a RAW file, is not possible. What you capture is what you get.
- Interpolating or upsizing an image initially saved as a JPEG can result in less than ideal results. Some 3rd party software applications can do this better than others, but you're still dependent on using another software application to get the job done.
- With specific types of photographed scenes JPEG compression artifacts can appear in prints.

Which Format Is The Better Format To Use?

Only you can say which is the correct file format to use after matching the pros and cons to your photographic needs and goals. An argument can be made for both formats. Some photographers will feel more strongly in backing the use of one versus another, but it is ultimately an individual choice. Personally, I shoot RAW + L (large) JPEG as my camera supports it and it provides me greater flexibility. For photographs that I've exposed correctly, JPEGs allow me a faster path to share images online and selectively use for printing. For photographs that I am interested in having published or printed, I begin my post-processing from the RAW file and make alterations in lossless file formats (PSD or TIF). The end result is the production of images that I feel are of the highest quality.

If you happen to have an eye to the future, then RAW may be the way to go as it will afford you the greatest long-term flexibility. I would anticipate that, as digital photography and photo editing software mature, greater editing options will become available to those shooting RAW. Image development has undergone a revolution where complicated algorithms, complex mathematical equations, are run against RAW data to produce new output for an image. In the future you may find it possible to load RAW files and run software that will change how an image looks on the fly. This may allow you to mimic the output equivalent to any number of film types. Digital photography is in its early stages; as cameras and software mature a variety of new opportunities will be made to photographers. The trick with anything digital is looking to the future and aligning yourself to be ready for those opportunities.

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10 Things Photographers Should NOT Do

We usually see photography tips on the things we should be doing, so I thought it would be interesting to turn it around and look at the things photographers should not be doing.

The items in my list are not comprehensive by any means, but I find them to be fairly important with regard to most photographers out there. And of course, these are only suggestions and opinions… so don't get too twisted up about them.

1. DON'T EXPECT RESULTS OVERNIGHT

Learning photography takes time — and that goes for the artistic and technical aspects. Sure, you might be artistically and/or technically inclined, but you probably won't have galleries begging for your photos a month after you pick up your first camera. The process of learning photography and developing a personal style can take years (or even a lifetime). Just keep at it and you should start to notice improvements in your work as the months turn to years.

2. DON'T LUST FOR NEW GEAR

New gear is exciting, isn't it? Bigger better cameras, faster lenses, filters, tripods, flashes, bags, etc. Don't get me wrong — it's fine to get excited over this stuff. But don't make it your life's goal to constantly buy the next best thing on the market. My advice is to buy new gear when you need it rather than when you want it. You'll know that you need something when you repeatedly find yourself missing opportunities (or even paying jobs) due to a lack of some feature or piece of equipment.

3. DON'T BE AFRAID TO FAIL

This one goes for anything in life — failure leads to success, improvement, and learning. You might screw up one or two shots from time to time, but you'll remember those mistakes next time you head out (and hopefully you won't make them again).

4. DON'T GET COCKY

Whether it's seemingly justified or not, nobody really likes a cocky bastard. So you sold a print, got into a gallery exhibit, got featured on some big website, etc — that's great, but don't let it go to your head. Don't talk down to other photographers or put yourself on a pedestal. If you do, it's only going to drive people away.

5. DON'T IGNORE THE CRITICS

If you share your photos anywhere on the web, you've probably had unsolicited critiques. Of course, you're more than welcome to ignore them, but it usually doesn't hurt to read them and think about it. You might just learn something or improve a photo. But, keep in mind that not all advice is good advice.

6. DON'T MAKE IT COMPLICATED

Photography is relatively simple on the technical side. Too many times, I've seen new photographers get hung up worrying about modes and settings when they really don't need to. As you continue to shoot and educate yourself, you'll pick up the technical stuff quite easily. Besides, if you worry too much about the technical side, you're more likely to miss shots entirely.

7. DON'T STEAL IDEAS

This goes for any form of creative expression. If you borrow a concept from another photographer, make sure you give them credit. And look at it this way — if you inspired others to create new things, wouldn't you like it if they gave you recognition for that?

8. DON'T NEGLECT YOUR GEAR

Cameras and other photographic equipment can be delicate at times. With the cost of cameras and lenses today, it's worthwhile to take care of them. Try not to bang it around on things, drop it, get it wet, etc. And keep your gear clean if you want it to last — lens elements and sensors in particular.

9. DON'T IGNORE "THE RULES"

The rule of thirds, symmetry, leading lines, perspective, background, depth of field, framing, crop, and so on. You've probably come across some of the basic rules of photography either on the web or in a book. Then you also see advice out there saying "break the rules". So what's the answer? Follow them? Break them? Here's the thing… there's a major difference between breaking the rules on accident and breaking the rules on purpose. It's called intent, and that's what separates the good from the bad. So learn the rules, then learn how to break them.

10. DON'T STOP LEARNING

Probably the worse thing a photographer (or any hobbyist/professional) can do is stop learning. There is a ton of stuff to learn about photography and art in general, and the flow of new information only increases as technology advances. So always be open to learning new things — even if you think you know it all!

Digital Noise & Film Grain	Noise in digital photos consists of any undesirable flecks of random color in a portion of an image that should consist of smooth color. It is somewhat similar to the "snowy" appearance of a bad TV signal. Digital images shot in low light or with a high ISO setting often exhibit this undesirable noise. In a way, noise is the digital equivalent of film grain, but noise is generally undesirable, while grain can be desirable. In fact, some digital photographers will curse noise one minute, and the next they may try to create film grain in digital photos for an artistic effect.
Histogram	A histogram is a graph that depicts the tonal range of an image. The far left column represents 100% black pixels and the far right represents 100% white pixels, with all other tones spread in between. Most scanning software, photo editing software, and some digital cameras allow you to view an image's histogram. 
HDR	High Dynamic Range, or HDR, is a digital photography technique whereby multiple exposures of the same scene are layered and merged using image editing software to create a more realistic image, or a dramatic effect. The combined exposures can display a wider range of tonal values than what the digital camera is capable of recording in a single image.

Using manual mode is an excellent way to learn about the relationship between ISO, aperture and shutter speed. The purpose of this exercise is to slow down the shooting process and get you thinking about the relationship between these elements of the exposure triangle.
In manual mode, there will be an indication in your viewfinder as to whether the exposure settings you have selected are correct *according to the camera's built-in meter*. Check your instruction manual to see how it works on your camera.

The above diagrams show how it works on Canon EOS cameras. The arrow shows that the top display is correctly exposed, the middle display is overexposed by a stop, and that the bottom display is underexposed by a stop.