Three Countries

Metaphorically, there are three “countries” on your camera: ISO, lens opening, and shutter speed.

ISO

ISO is the sensitivity of the camera sensor to light.
The sensor is what records your photographs.
Turn down the ISO “volume” in bright light.
Turn up the ISO volume in dim light.

<table>
<thead>
<tr>
<th>Light Condition</th>
<th>ISO Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>100 to 200</td>
</tr>
<tr>
<td>Shady or cloudy</td>
<td>400</td>
</tr>
<tr>
<td>Dim*</td>
<td>800 to 3200</td>
</tr>
</tbody>
</table>

* No flash

Noise

Noise increases as you turn the ISO volume up.
Noise is:
• Graininess.
• Wrong-colored pixels, usually green and magenta (pink).
Noise isn’t always detrimental to a photograph.

Auto ISO

Your camera is probably set by default to Auto ISO.
The camera’s light meter measures the brightness of the light, and sets the ISO accordingly.
Generally, Auto ISO works well, except when you’re using long exposures on a tripod in dim light.
The next two countries control how much light reaches the sensor.

**Lens Opening**

The lens opening is the “iris” in your lens.

It’s also called aperture or f/stop.

Here are the “major” lens openings for digital SLR cameras with zoom lenses.

| f/4 | f/5.6 | f/8 | f/11 | f/16 | f/22 |

Here are the major lens openings for point-and-shoot cameras.

| f/2* | f/2.8 | f/4 | f/5.6 | f/8 |

* Some point-and-shoot cameras

There are many more lens-opening numbers on your camera.

Above, the lens openings differ by one stop of light.

On your camera, the lens openings differ by 1/3rd of a stop.

**Shutter Speed**

The shutter consists of blades that open and close.

Here are the most used shutter speeds for both digital SLR cameras and point-and-shoot cameras.

<table>
<thead>
<tr>
<th>1/8</th>
<th>1/15</th>
<th>1/30</th>
<th>1/60</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/125</td>
<td>1/250</td>
<td>1/500</td>
<td>1/1000</td>
</tr>
</tbody>
</table>
Just like lens openings, there are many more shutter-speed numbers on your camera.

Above, the shutter speeds differ by one stop of light.

On your camera, the shutter speeds differ by 1/3\textsuperscript{rd} of a stop.

**Which One Is Which?**

The lens openings and shutter speeds on your camera may not be obvious.

Your camera may display both the numerator and denominator of a shutter speed fraction: 1/x.

That makes it easy to tell lens openings from shutter speeds, as lens openings don’t have numerators: 1/x.

If your camera doesn’t display numerators, check your instruction manual for the locations of the lens openings and shutter speeds.

BTW—shutter speeds with quote marks are full seconds.

8” is eight seconds, not 1/8\textsuperscript{th} of a second.

**The Bigger the #, the < Light**

When you change the lens opening and shutter speed numbers, it’s hard to understand what you’re doing.

In the illustrations below, the boxes change from white to black.

The tonal change represents how much light is passing through the lens opening or shutter blades.
A mnemonic is: The bigger the number—the less light is reaching the sensor.

The term *bigger* is used here loosely, not mathematically.

**Digital SLR Cameras**

| f/4 | f/5.6 | f/8 | f/11 | f/16 | f/22 |

**Point-and-shoot Cameras**

| f/2 | f/2.8 | f/4 | f/5.6 | f/8 |

**All Cameras**

| 1/8 | 1/15 | 1/30 | 1/60 |

| 1/125 | 1/250 | 1/500 | 1/1000 |

**Exposure Mode Dial**

The exposure mode dial is probably on top of your camera.

Here, we’ll look only at the letters on the dial: P, A or Av, and S or Tv.

**P (Program)**

When using P (Program), the camera sets the lens opening and the shutter speed.

<table>
<thead>
<tr>
<th>You Set</th>
<th>The Camera Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Nothing</td>
</tr>
<tr>
<td></td>
<td>Lens opening &amp; shutter speed</td>
</tr>
</tbody>
</table>
5

A or Av (Aperture Priority)
When using A or Av (aperture priority), you set the lens opening.
The camera sets the shutter speed.

<table>
<thead>
<tr>
<th>You Set</th>
<th>The Camera Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/Av</td>
<td>Lens opening</td>
</tr>
<tr>
<td></td>
<td>Shutter speed</td>
</tr>
</tbody>
</table>

S or Tv (Shutter Priority)
When using S or Tv (shutter priority), you set the shutter speed.
The camera sets the lens opening.

<table>
<thead>
<tr>
<th>You Set</th>
<th>The Camera Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>S/Tv</td>
<td>Shutter speed</td>
</tr>
<tr>
<td></td>
<td>Lens opening</td>
</tr>
</tbody>
</table>

When Do You Use Each One?
Use A/Av when depth-of-field is important.
Use S/Tv when motion is important.
Use P when depth-of-field and motion are not important.
Let's look at depth-of-field and at motion.

Depth-of-field
Depth-of-field is how much is in acceptable focus.
Let's say you focus on the middle of a flower.
So, the middle of the flower is sharp.
But, will the entire flower be acceptably sharp?
Will there be enough depth-of-field so the entire flower is acceptably sharp?

Depth-of-field is determined by two factors: lens opening and distance to the subject.

1 - Lens Opening

*Digital SLR Cameras*

Use f/4, or thereabouts, for less depth-of-field.

Use f/22, or thereabouts, for more depth-of-field.

You need bright light to use f/22.

*Point-and-shoot Cameras*

Point-and-shoot cameras have lots of depth-of-field at all lens openings.

That’s:

- Good for close-ups, as everything is acceptably sharp.
- So-so for portraits, as it’s hard to blur the background.

2 - Distance to the Subject

Depth-of-field is critical when photographing a flower, for example.

That’s because depth-of-field decreases as you come closer to the subject.

If everything in the frame is more than about fifteen feet away, depth-of-field doesn’t matter.

<table>
<thead>
<tr>
<th>DOF Is</th>
<th>Critical</th>
<th>Very close to the subject</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Important</td>
<td>Under about 15 feet</td>
</tr>
<tr>
<td></td>
<td>Not Important</td>
<td>More than about 15 feet</td>
</tr>
</tbody>
</table>
Depth-of-field Myth

Depth-of-field is not dependent on focal length.
Focal length is whether your zoom lens is set to wide angle, telephoto, or in between.
The depth-of-field is the same if you’re lens is set to wide angle) or if it’s set to telephoto.

Motion

Use S or Tv if motion is important.
The motion can be at two locations: subject and camera.

1 - Subject Movement
Use 1/1000th to freeze subject motion.
You need bright light to use 1/1000th.
Use 1/8th to blur subject motion.
You need dim light to use 1/8th, as well as a tripod, bean bag, or other camera support.

2 - Camera Shake
Camera shake occurs when using a slow shutter speed and a handheld camera.
You may get camera shake when you’re photographing indoors without flash.
To avoid camera shake, set:
• The exposure mode dial to S or Tv.
• The shutter speed to 1/60th.
Exposure Mode Dial Summary

<table>
<thead>
<tr>
<th>You Set</th>
<th>The Camera Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Nothing</td>
</tr>
<tr>
<td>A/Av</td>
<td>Lens opening</td>
</tr>
<tr>
<td>S/Tv</td>
<td>Shutter speed</td>
</tr>
</tbody>
</table>

You use P, A/Av, or S/Tv when . . .

<table>
<thead>
<tr>
<th>Use</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/Av</td>
<td>Depth-of-field is important.</td>
</tr>
<tr>
<td>S/Tv</td>
<td>Motion is important.</td>
</tr>
<tr>
<td>P</td>
<td>The above are not important.</td>
</tr>
</tbody>
</table>

Note

When you use P, A/Av, and S/Tv, you’re not changing the brightness of the photograph.

Let’s say you’re experimenting with depth-of-field.

You set the exposure mode dial to A/Av.

You take photographs at f/4, f/5.6, f/8, f/11, f/16, and f/22.

The depth-of-field changes in six photographs.

The brightness of the six photographs is the same.

That’s because when you changed the lens opening—the camera changed the shutter speed to compensate.
For every "step forward" you do with a lens opening—the camera "steps back" with a shutter speed. The amount of light reaching the sensor stays the same.

You change the lens opening from f/4 to f/5.6.

The camera changes the shutter speed to 1/125 to 1/60.

No Change in the Brightness

This is a difficult concept to understand. We'll return to the topic below.

Visualizations

The next three cards depict the three countries on your camera: ISO, lens opening, and shutter speed.

Note how the increase or decrease in a concept is shown by the changing size of the area depicting the concept.
Visualization #1: ISO

800 to 3200

400

100 to 200

Sunny

Shady/Cloudy

Dim (No Flash)
Digital SLR camera lens openings are black, and point-and-shoot camera lens openings are gray.

Visualization #2: Lens Opening

- f/8
- f/5.6
- f/4
- f/2.8
- f/2
- f/8
- f/5.6
- f/2.2
- f/2.0

Dim --- (Amount of light in the scene) --- Bright

Blgger --- (Physical size of the lens opening) --- Smaller

Less --- (Depth-of-field: How much is in focus) --- More
Visualization #3: Shutter Speed

1/8 1/15 1/60 1/125 1/250 1/500 1/1000

Dim ———— (Amount of light in the scene) ———— Bright

Slow ———— (How long the blades stay open) ———— Fast

Blurred Moving Subject / Camera Shake ———— Frozen
WYSINWYG

When you press the shutter release, what you see is not what you get.

Contrast Increases

Shadows become darker on photographs.

It’s difficult to have both shadows and bright areas on the same photograph.

If the increase in contrast is detrimental, do the following.

1) Crop out the brightest area, or the darkest area, in the scene.
2) Return to the scene when the light is less contrasty, such as an overcast sky or shade.
3) If the subject is close, use fill flash to brighten the shadows.
4) A Polarizing filter darkens blue skies.
5) A graduated neutral density filter darkens bright skies.
6) Set your camera to a lower contrast setting.

White Balance (WB)

Our visual system corrects the color in the scenes before our eyes.

For example, old-fashioned light bulbs produce orange light.

We see the orange light as white light, however.

Cameras attempt to do the same color correction with automatic white balance.

For better color fidelity, set the white balance to match the color of the light in the scene.
### Auto (AWB)

<table>
<thead>
<tr>
<th>Auto White Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
</tr>
<tr>
<td>Reduces cyan (blue/green)</td>
</tr>
<tr>
<td>Reduces blue</td>
</tr>
<tr>
<td>Reduces orange</td>
</tr>
<tr>
<td>Reduces green</td>
</tr>
<tr>
<td>Reduces blue</td>
</tr>
<tr>
<td>Ignore**</td>
</tr>
</tbody>
</table>

* Old-fashion light bulbs and halogen lamps

** Beginners should ignore. When the colors of the light sources in a scene are different, and no single color predominates, set a custom white balance.

### Exposure Compensation

When you press half-way down on the shutter release, the light meter in your camera measures the light and the exposure is set.

Use exposure compensation to change the brightness of a photograph.

Look for the +/- button or a number line on your LCD screen.

#### Plus

A positive value makes the photograph brighter.

Try "plus" when:

- The subject is backlit and is in silhouette.

Use fill flash when the subject is within about fifteen feet, instead of exposure compensation.

By using fill flash, the background won’t be washed out as it would be if using exposure compensation.
Photographing white subjects in the sun, such as snow.
Try +1.7.

Minus
A negative value makes the photograph darker.
Try “minus” when:
• You want richer colors.
• Photographing dark subjects in the sun, such as a black Labrador dog.
Try -1.3.

Exposure Compensation Summary

<table>
<thead>
<tr>
<th>-2.0</th>
<th>-1.0</th>
<th>0.0</th>
<th>+1.0</th>
<th>+2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Richer color</td>
<td>• Backlighting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Black dogs*</td>
<td>• Snow*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In the sun

Example
On the next card, three photographs were taken of a ballerina at different brightness levels.

Middle Photograph
In the middle, 0.0 is the normal brightness.

Top Photograph
At the top, -1.0 is one stop darker.
At the bottom, +1.0 is one stop brighter.

-1.0

One Stop Darker
(1/2 the Light)

0.0

Normal Brightness

+1.0

One Stop Brighter
(Double the Light)
17

Language of Stop

Again, the three countries on your camera are ISO, lens opening, and shutter speed.

The three countries are part of the Camera Union, so they have a common “language” called Stop.

The language is simple.

One Word

It has only one word: Stop.

Definition

The definition of Stop is:

A Stop is a quantity of light.

A Quantity of Light: One Stop

Grammar

The “grammar” is easy.

Stops do two things.

They:

1) Double.

2) Halve.
If you add a stop of light, the quantity of light doubles.

If you add another stop of light, the quantity of light doubles.

If you add another stop of light, the quantity of light doubles.
19

If you *subtract* a stop of light, the quantity of light *halves*.

If you *subtract* another stop of light, the quantity of light *halves*.

If you *subtract* another stop of light, the quantity of light *halves*.
The Language of Stop & ISO

The language of stop is easy with ISO.

The sensitivity of the sensor doubles:

| 100 to 200 | Doubles the sensitivity | By one stop |
| 200 to 400 | Doubles the sensitivity | By one stop |
| 400 to 800 | Doubles the sensitivity | By one stop |

The sensitivity of the sensor halves:

| 800 to 400 | Halves the sensitivity | By one stop |
| 400 to 200 | Halves the sensitivity | By one stop |
| 200 to 100 | Halves the sensitivity | By one stop |

The Language of Stop & Lens Opening

The language of stop isn’t as easy with lens openings.

The lens-opening numbers don’t double or halve.

The amount of light halves:

| f/4 to f/5.6 | Halves the light | By one stop |
| f/5.6 to f/8 | Halves the light | By one stop |
| f/8 to f/11 | Halves the light | By one stop |

The amount of light doubles:

| f/11 to f/8 | Doubles the light | By one stop |
| f/8 to f/5.6 | Doubles the light | By one stop |
| f/5.6 to f/4 | Doubles the light | By one stop |
The Language of Stop & Shutter Speed

The language of stop is easy with shutter speeds.

The sensitivity of the sensor doubles:

- $1/60^{th}$ to $1/125^{th}$: Halves the light, By one stop
- $1/125^{th}$ to $1/250^{th}$: Halves the light, By one stop
- $1/250^{th}$ to $1/500^{th}$: Halves the light, By one stop

The sensitivity of the sensor halves:

- $1/500^{th}$ to $1/250^{th}$: Doubles the light, By one stop
- $1/250^{th}$ to $1/125^{th}$: Doubles the light, By one stop
- $1/125^{th}$ to $1/60^{th}$: Doubles the light, By one stop

Next, we’ll look at how two of the countries trade stops back-and-forth.

Trading Apples

One could use the language of stop in this section.

However, for clarity, we’ll ignore the doubling and halving.

Instead, we’ll use the language of apples.

Let’s get going.

When you change the shutter speed—what happens to the lens opening?

How do these two countries work together?

Let’s say you’re photographing a pirouetting ballerina.

BTW—if you read this section carefully—even though it’s boring—your photography will gain.
Motion is important.
Therefore, you set the exposure mode dial to S/Tv.

With S/Tv:
- You set the shutter speed.
- The camera sets the lens opening

You want to blur the motion.
You need a slow shutter speed.
You set the shutter speed to 1/8th.

There's lots of light coming through the shutter at 1/8th.
So, the camera can't let much light pass through the lens opening.
It sets a physically small lens opening of f/16.
f/16 doesn't let much light through.

Here are the exposure settings.

| 1/8th | f/16 |

Let's say the sensor needs "six apples" of light for the correct brightness of the photograph.
Below, **five apples** of light are going through the slow shutter.

Above and to the right, **one apple** of light is passing through the physically small lens opening.

Here's the "six-apples-of-light" photograph.

Five apples-of-light went through the shutter.

One apple-of-light passed through the lens opening.
The ballerina is too blurry.
You select a faster shutter speed: 1/8<sup>th</sup> to 1/15<sup>th</sup>.
Less light is going through the shutter.
So, the camera changes the lens opening from f/16 to f/11.
More light is passing through the lens opening.
The sensor is still getting six apples of light.
But:
• Fewer apples are going through the shutter.
• More apples are passing through the lens opening.

Here’s the photograph.

<table>
<thead>
<tr>
<th>Shutter Speed</th>
<th>Len Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Settings</td>
<td>1/8 f/16</td>
</tr>
<tr>
<td>New Settings</td>
<td>1/15 f/11</td>
</tr>
</tbody>
</table>
Oops—she’s still too blurry.

You select a faster shutter speed: 1/15th to 1/30th.

Less light is coming through the shutter.

So, the camera changes the lens opening from f/11 to f/8.

More light is passing through the lens opening.

<table>
<thead>
<tr>
<th>Shutter Speed</th>
<th>Lens Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Settings</td>
<td>1/15, f/11</td>
</tr>
<tr>
<td>New Settings</td>
<td>1/30, f/8</td>
</tr>
</tbody>
</table>

The sensor is still getting six apples of light.

Here's the photograph.
Darn—she’s still too blurry.
You select a faster shutter speed: 1/30th to 1/60th.
Less light is coming through the shutter.
So, the camera changes the lens opening from f/8 to f/5.6.
More light is passing through the lens opening.

### Shutter Speed | Lens Opening
--- | ---
Old Settings | 1/30 | f/8
New Settings | 1/60 | f/5.6

The sensor is still getting six apples of light.
Here’s the photograph.
Drat—she’s still too blurry.

You select a faster shutter speed: 1/60<sup>th</sup> to 1/125<sup>th</sup>.

Less light is coming through the shutter.

So, the camera changes the lens opening from f/5.6 to f/4.

More light is passing through the lens opening.

The sensor is still getting six apples of light.

Here's the photograph.

As you can see—when you changed the shutter speed—the camera changed the lens opening.
Apples were “traded” between the shutter and the lens opening.

**Compare**

Compare the five photographs below.

**Observation #1**

You changed the shutter speed—so the amount of blur changed in the photographs.

**Observation #2**

The sensor got the same amount of light in every photograph—even though the exposure settings changed.

That’s because when you changed the shutter speed, the camera compensated for the change by changing the lens opening.
Here are the different exposure settings from our example.
Every time you changed the shutter speed—by **one stop less** light . . .
. . . the camera changed the lens opening—by **one stop more light**.

<table>
<thead>
<tr>
<th>1/8</th>
<th>f/16</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/15</td>
<td>f/11</td>
</tr>
<tr>
<td>1/30</td>
<td>f/8</td>
</tr>
<tr>
<td>1/60</td>
<td>f/5.6</td>
</tr>
<tr>
<td>1/125</td>
<td>f/4</td>
</tr>
</tbody>
</table>
The illustration below depicts the same concept visually.
Exposure Compensation

Remember, six apples of light is what the light meter determined was needed for the sensor.

As discussed above, you may not want six apples of light.

Light meters are stupid.

You’re smarter.

Use exposure compensation to vary the number of apples—to vary the brightness of the photograph.

Sometimes, you want a photograph to be lighter or darker.
Check List

When you change a setting on your camera, you have to remember to change it back!

Fold this card in half, and keep it with your camera as a reminder to check the settings.

- Battery
- Number of photographs left
- Quality (Raw, JPEG quality)
- ISO
- P, A/Av, S/Tv
- White balance (WB)
- Exposure compensation (+/-)
Consider Changing These Default Settings On Your Camera

Display a Grid
Some cameras can display a tic-tack-toe grid.
This aids with composition (Rule of Thirds), and with keeping horizons level.

EV Stops
Your camera is probably set to EV stop increments of .3.
That means you have to scroll through many f/stops and shutter speeds.
Look for the phrase EV Stops in your camera’s menu.
Change it to .5.

Auto ISO
Your camera is probably set to increase the ISO automatically if there’s too little light.
That’s fine if you’re a beginner.
Others may want to set the ISO.

Automatic Focus Area Selection
Your camera probably selects where to focus.
The camera may focus on the closest object.
If so, the focus may be on something in the foreground and not the subject.
Set the camera to focus in the middle of the frame.
Do the following.
1) Point the camera at the focus point you choose.
2) Lock in the focus by partially depressing and holding the shutter release.
3) Reframe the composition, if necessary

**Evaluative or Matrix Metering**

The light meter in your camera is probably set for:

- Matrix metering (Nikon).
- Evaluative metering (Canon).
- Or similar exposure metering system.

When using one of the above exposure systems, many points in the frame are measured.

This set of brightness levels is then compared to samples on the camera computer.

The camera computer looks for a match between the scene and the stored samples.

This setting may set poor exposures for:

- Landscapes (bright sky, darker foreground).
- Backlighted subjects, producing silhouetted subjects.

If so, try center-weighted metering.

Most of the light is measured in the center of the frame.

Point this area at the area that you want to measure, and lock in the exposure.

Press and hold the AEL button (Nikon) or press and release the asterisks-icon button (Canon).