Chapter 3
Setting the Shutter Speed and Aperture

In this chapter we look at how the shutter and aperture control exposure—the brightness of a picture—and we introduce their creative side effects—blurring or freezing motion and decreasing or increasing depth of field. The camera has a manual shooting mode that works much like cameras have for the past 150 years. It's the only mode where you can directly change the aperture and shutter speed independently of each other. This manual mode is accompanied by a variety of automatic modes. Of these, the ones photographers use most often are aperture-priority (Av) and shutter-priority (Tv) because they give direct control over key exposure settings. There is also a fully automatic mode—Scene Intelligent Auto—that evaluates the scene and tries to determine the best possible settings for you. A final shooting mode is Bulb which you use for extremely long exposures such as those needed to capture star trails and light streaks from moving vehicles at night. When shooting RAW images you can use any of these modes and easily switch among them.
Chapter 3 Setting the Shutter Speed and Aperture

The most creative controls you have with any camera are the shutter speed and aperture settings. One thing they do is control the exposure—the total amount of light reaching the image sensor, and thus control how light or dark a picture is.

• The shutter opens to begin an exposure and closes to end it. It determines how long the image sensor is exposed to light.

• The aperture is an opening through which light enters the camera. The size of the opening can be changed to control the brightness of the light that enters.

In Manual (M) shooting mode you can adjust both of these settings. In aperture-priority (Av) and shutter-priority (Tv) modes you set one and the camera sets the other for the correct exposure. In Scene Intelligent Auto and Programmed AE (P) modes the camera sets both and in Bulb (B) and Manual (M) modes it sets neither.

Knowing how to control exposure is one of the most important aspects of photography. When a scene has both very light and very dark areas, getting the perfect exposure is a lot like parking a large car in a small garage—there isn’t a great deal of room for error. The goal is to hold details in both the darkest and lightest areas so pure white is used only for spectral highlights such as bright reflections off of chrome and pure black is used only for small areas of the scene that are black with no details.

As you’ll see in the following pages, by using the right combination of aperture and shutter speed you can do more than just get the exposure right. You can also freeze or blur motion or make the background in a landscape or portrait sharp or blurred.

In the early days of photography, plates—called waterhouse stops—were inserted into a slot in the lens to control the amount of light entering the camera. These stops had holes of various sizes drilled in them and they acted just like the adjustable iris apertures used today. A lens cap was removed from the lens to begin the exposure and replaced to end it—a primitive version of a shutter. This old wooden camera is surrounded by a number of waterhouse stops (apertures) and a lens cap (the shutter) leans against it. Photo by Åke Borgstrom at www.photographica.nu.

The 7D Mark II’s focal plane shutter uses two curtains—one opens to begin the exposure and the second closes to end it. At shutter speeds faster than 1/250 the two curtains form a slit traveling across the image sensor.

Less light makes an image darker (left) and more light makes it lighter (right).
TOPIC 3–1. SHUTTER SPEED & APERTURE—INTRODUCTION

**Tips**

- You can evaluate highlights and shadows using a histogram when shooting or reviewing your images.
- In P, Av, Tv and M shooting modes you use exposure compensation to make an image lighter or darker.

**Resources to Explore**

1. **Understanding Exposure** illustrates how the amount of light striking the image sensor determines how light or dark the captured image is. As the sensor gathers more light, the image becomes lighter. There is only one point, or perhaps a narrow range, where it is perfectly exposed. [www.photocourse.com/itext/exposure](http://www.photocourse.com/itext/exposure).

**Seeing for Yourself**

1. Find a high-quality book of Ansel Adams images, perhaps at your local or school library. While studying the photos notice how one of his hallmarks was his ability to retain details in both shadow and highlight areas.

2. Carefully go through some of your photos, especially those shot on bright sunny days. Have you retained detail in both highlights and shadows or have those areas gone pure black or white without details?

3. With your camera in Live View, set it to Manual (M) shooting mode. Turn the Main or Quick Control dials to adjust the aperture and shutter speed while watching the settings and the scene on the monitor change. The scene will get lighter or darker depending on how you change the two settings. Also, watch the exposure indicator that tells how much you are over or under the exposure calculated by the camera.

4. Display Target 5 Ten Step Grayscale in Appendix A full-screen. Set the camera to Manual (M) shooting mode with Live View on and adjust the aperture and shutter speed while watching the settings and the grayscale on the camera’s monitor. Try to find settings that retain details in all but the first and last steps which are pure white and black. As you do so watch how the camera indicates how far you are over or under the exposure calculated by the camera. Do you and the camera agree on the best settings?
A perfect exposure has detail in the lightest and darkest areas of the image and tones range from white to black.

In many scenes it’s important to get the exposure of the main subject right and let the other tones fall where they may. You can always try to open shadows and restore detail to highlights when editing.

Jabez Hogg Making a daguerreotype Portrait in Richard Beard’s Studio in 1843. He is holding a watch in his left hand to time the exposure and a lens cap in his right to end it. Courtesy Wikimedia Commons.

Sometimes you can’t capture all of the tones in an image, because the range is too great, so details in the highlights or shadows are lost. The effect can be used creatively.
One of the things that makes an Ansel Adams print so stunning was his ability to hold details in both the brightest and darkest parts of a scene. To do this with film he developed the Zone System that guided him in adjusting exposure and development times for the best results. Today the adjustments are made in programs such as Photoshop and Lightroom.

This photo by Ansel Adams “The Tetons—Snake River,” Grand Teton National Park, Wyoming hints at his ability to totally control the tones in an image. To see the full effect you have to see an original print may by Ansel himself. Image from the series Ansel Adams Photographs of National Parks and Monuments, compiled 1941–1942, documenting the period ca. 1933–1942. Courtesy Wikimedia Commons.

In this Ansel Adams photo “Evening, McDonald Lake” taken in Glacier National Park, Montana the exposure is perfect. A little less exposure and the dark areas would have gone black. A little less and the highlights would have gone white. Courtesy Wikimedia Commons.
The shutter speed and aperture control exposure but they also have creative side effects. For example, you can pair a fast shutter speed (to let in light for a short time) with a large aperture (to let in bright light) or a slow shutter speed (long time) with a small aperture (dim light).

Speaking of exposure only, it doesn’t make any difference which combination you use because the exposure remains unchanged. But in other ways it does make a difference, and it is this difference that presents creative opportunities. Whether you know it or not, you’re always balancing camera or subject movement against depth of field because a change in one causes a change in the other.

• The shutter speed controls the way motion is portrayed in an image. You can select a fast speed to freeze motion or a slow one to blur it.

• The aperture controls depth of field—the sharpness of an image from foreground to background. You can select a small aperture to increase depth of field or a large one to decrease it.

When you press the shutter button halfway down, check the readouts in the viewfinder. If the aperture or shutter speed are blinking, you have exceeded the camera’s ability to get a good exposure. In low light you may have to pick a larger aperture, slower shutter speed, higher ISO or use flash. In bright light, you may have to use a smaller aperture, faster shutter speed or lower ISO.

### Stops

The trade-off of shutter speeds and apertures works because shutter speeds and apertures each have a standard series of settings called “stops”. These stops are arranged so that a change of 1 stop lets in half or twice the light of the next setting.

• With shutter speeds, each stop is a second or more, or a fraction of a second indicating how long the shutter is open. A shutter speed of 1/60 second lets in half the light that the slower 1/30 second does, and twice the light of the faster 1/125 second.

• With apertures, f/stops indicate the size of the opening through which light enters. An aperture of f/5.6 lets in half the light that the larger f/4 does, and twice the light of the smaller f/8.

If you make the shutter speed 1 stop slower (letting in 1 stop more light), and an aperture 1 full stop smaller (letting in 1 stop less light), the exposure doesn’t change. (This is exactly how Av and Tv modes work.) Although the exposure doesn’t change the slower shutter speed increases the possibility of blur from camera or subject movement and the smaller aperture increases depth of field slightly. A one-stop change like this has only a small effect, but the effects of a 3 or 4 stop change can be dramatic. For example with a three stop change the shutter speed might drop from 1/125 to 1/15 and the aperture might stop-down from f/2.8 to f/8. The effects of those changes on blur and depth of field would be very noticeable.

### Exposure—Faucets & Buckets Analogy

One way to think of apertures and shutter speeds is to use the analogy of a water faucet for the aperture and a timer for the shutter speed.

• When you open a faucet all the way, water gushes out so you fill a bucket in a very short time. This is the same as pairing a large aperture and fast shutter speed to let in bright light for a short time.

• When you open a faucet just a little, water trickles out and so it takes longer to fill a bucket. This is the same as pairing a small aperture and slow shutter speed to let in dim light for a longer time.

No matter which combination you choose, the bucket can be filled the same amount. Likewise, an image in a camera can be exposed the same amount by various aperture and shutter speed combinations while also controlling motion and depth of field.
**Exposure—Seesaw Analogy**

Another way to think of exposure is as a seesaw. As one child rises a given distance, the other falls by the same amount but their average distance from the ground is always the same. In photography, when you or the camera change the aperture or shutter speed to let in more or less light, you or the camera must also change the other setting in the opposite direction to keep the exposure constant.

The following illustrations show how a change in the aperture setting must be matched by a change in the shutter speed and vice versa. As these offsetting changes are made, the exposure stays constant but depth of field changes slightly and subjects are more or less likely to be frozen.
**Exposure Values (EV)**

In the examples above, you have been exploring what are commonly called exposure values (EV) that indicate all combinations of a camera’s shutter speed and aperture that give the same exposure. You will find these at work in aperture-priority (Av) and shutter-priority (Tv) modes where a change in one setting automatically causes a change in the other to keep the exposure the same. You will also see it directly at work in program shift where you can select any one of a variety of shutter speed/aperture combinations for an image. In this book we normally use the term “stop” which is equal to 1EV but in other literature you may encounter the EV term, especially in regards to exposure compensation. For example, you may read that exposure has been increased 1EV which means it’s been increased one stop to double the exposure and lighten the image.

**Troubleshooting Sharpness**

If your photos aren’t as sharp as you want them to be, you can analyze them to see what went wrong.

- **Focus.** If nothing in your image is sharp or if your central subject is not sharp but other parts of the photograph are, your camera was improperly focused.

- **Depth of Field.** If your central subject is sharp but the background or foreground is less so, you may not have used a small enough aperture to get the depth of field you wanted.

- **Camera Movement.** If the image is blurred all over, with no part sharp, the camera moved during the exposure. Some dots appear as lines and edges are blurred because the image was “painted” onto the moving image sensor.

- **Subject Movement.** When some of the picture is sharp but a moving subject appears blurred, your shutter speed was too slow.

**Resources to Explore**

1. **Aperture-Shutter Speed Equivalents** shows that there is often more than one aperture-shutter speed combination available that gives the same exposure. As shown here by the pairs connected by the red line as you click them. You’ll see that when the aperture gets larger to let in more light, the shutter speed gets faster to keep the exposure constant. [www.photocourse.com/itext/seesaw](http://www.photocourse.com/itext/seesaw).

2. Search the Internet for the term “exposure value” to see what you can find out about this concept.

3. Search the Internet for the term “exposure simulator” to find simulators that let you explore the effects that shutter speeds, apertures and even ISO settings have on your pictures.

**Seeing for Yourself**

1. Put the camera in Live View and Program AE (P) shooting mode. In a fairly bright setting use program shift to change the exposure while watching the monitor as you scroll through the available aperture and shutter speed combinations. All of the pairs give the same exposure. Try the same in a dim room to see if there are fewer pairs available because you have reached the limit of one of the settings.
2. Set the camera to aperture-priority (Av) shooting mode and change the aperture as you watch the shutter speed automatically change on the monitor to keep the exposure constant. You may have to press the shutter button halfway down to see the change.

3. Set the camera to shutter-priority (Tv) shooting mode and change the shutter speed as you watch the aperture automatically change on the monitor to keep the exposure constant. You may have to press the shutter button halfway down to see the change.

4. With the camera in Tv shooting mode, set the shutter speed to 8000, go into a dark room or closet and press the shutter button halfway down. The point here is to see which exposure setting blinks to warn you there isn’t enough light.

5. With the camera in Live View and Manual (M) shooting mode change the aperture and shutter speed while watching the settings and the scene on the monitor. Try to find two pairs of settings that give the same exposure. Notice how the vertical exposure level indicator on the right side of the viewfinder lets you know how far you are over or under the exposure calculated by the camera.

When you select a large aperture to freeze motion you sometimes make the background out of focus. Occasionally lights in the background become circles called bokeh which is discussed later in this book.

Here the depth of field was the most important setting since the scene is deep and static.
To capture pictures with the correct brightness you adjust the aperture and shutter speed. Not too long ago all cameras had one shooting mode you used to do this, what we now call Manual (M) mode. Eventually the first two automatic modes were added—aperture-priority (Av) and shutter-priority (Tv). Most of the great photographs you remember seeing were probably taken with these three modes—and many of those were probably taken using manual mode before any automatic modes became widely available in the 1960s.

### Changing Shooting Modes

1. Set the Power Switch to ON.
2. Hold down the Mode dial’s lock release button and turn the dial so the desired shooting mode aligns with the small white marker on the camera’s body.

### Shooting Modes

Your 7D Mark II offers the following 7 shooting modes, each of which has unique advantages in specific situations.

- **Intelligent Auto mode** sets the shutter speed and aperture without your intervention. This allows you to shoot without paying attention to settings so you can concentrate on composition and focus. In this mode you can’t change many camera settings so you can’t make many mistakes. This mode is discussed in detail in Topic X–Y.

- **Program AE (P) mode** is just like auto in that it sets the aperture and shutter speed for you, but unlike auto it lets you change many of the camera’s settings. In this mode you can use a feature called *program shift* that lets you select from a series of paired aperture and shutter speed combinations that yield the same exposure as that recommended by the camera. This gives you control over how depth of field and motion are captured. One of the best things about this mode is that it prevents you from inadvertently selecting an exposure setting that exceeds the camera’s range.

- **Shutter-priority (Tv) mode** lets you choose the shutter speed and the camera automatically selects the aperture needed for a good exposure. You select this mode when the portrayal of motion is most important. For example, when photographing action scenes, such as those encountered by wildlife photographers, sports photographers, and photojournalists, this mode might be best. It lets you be sure your shutter speed is fast enough to freeze the action or slow enough to blur it.

- **Aperture-priority (Av) mode** lets you select the aperture and the camera automatically selects the shutter speed needed for a good exposure. You select this mode whenever depth of field is most important. To be sure everything is sharp, as in a landscape, select a small aperture. The same holds true for close-up photography where limited depth of field is always a major concern. To throw the background out of focus so it’s less distracting, as in a portrait, select a large aperture.

- **Manual (M) mode** lets you select both the shutter speed and the aperture. The two are not linked as they are in all other modes. You normally use this mode only when the other modes can’t give you the results you want. Some cameras have a bulb setting in this mode that keeps the shutter open as long as you hold down the shutter button so you can capture time exposures such as light trails at night from moving cars.

- **Bulb Exposures (B) mode** keeps the shutter open as long as you hold the shutter button all the way down. You control the exposure by how long you hold down the shutter button and the aperture you select by turning the Main or Quick Control dial.

- **Custom (C1 to C3) mode** lets you store personal settings so you can use them over and over again just by selecting the mode they have been saved to with the Mode dial. This is as simple as setting the camera the way you want it and then selecting the menu command that saves the current settings to the custom mode.

### Algorithms

Since there is often more than one combination of aperture and shutter speed to get a good exposure, the camera has to pick one. Cameras automatically do a number of things such as this using *algorithms*—sets of rules for solving a problem in a finite number of steps. It’s such an algorithm that determines whether the selected settings are f/8 at 1/30th of a second or f/4 at 1/125th—either of...
which gives the same exposure. If the camera has scene modes the sports mode will be biased toward a faster shutter speed to freeze action and the landscape mode will be biased toward a small aperture for greater depth of field.

**Tips**

- In some situations, your pictures can be too light or too dark in any shooting mode. To darken or lighten them, use exposure compensation.
- Check the shutter speed and aperture in the viewfinder when you press the shutter button halfway down. If either is blinking, the camera doesn’t have the right exposure setting. If this happens, try using flash or adjust the ISO.
- In most shooting modes the ISO may automatically increase in low light, creating noise in your images.
- In some lighting, your pictures can be too light or dark in any exposure mode. To adjust their brightness, use exposure compensation.
- You’ll find that not all settings can be changed in all shooting modes and not all features are available.
- The camera remembers the shooting mode you last used even if you turn the camera off and back on.

**Resources to Explore**

1. Search the Internet for “camera exposure algorithms” to see what you can learn about this technology.
2. Search the Internet for “Canon exposure algorithms” to see how Canon handles this aspect.

**Seeing for Yourself**

1. Turn the Mode dial to each of its shooting modes and in each mode turn the Main and Quick Control dial’s as you watch settings on the LCD panel. Do you see what settings are being changed?

*Here the shutter speed is 1/640 and the aperture is f/6.3.*
In Scene Intelligent Auto shooting mode, your camera is automatically set to produce the best possible exposure. Program AE (P) mode is also fully automatic, but only the aperture and shutter speed are set automatically. You can change other settings including all of those you can change in other modes.

**Using Program AE (P) Mode**
1. Set the Power Switch to ON.
2. Set the Mode Dial to P (for Program AE).

One feature of Program AE mode, called program shift, let’s you scroll through pairs of aperture and shutter speed combinations that offer identical exposures. By choosing the right combination you can choose to control depth of field or motion capture.

- To freeze or blur motion select the pair with the fastest or slowest shutter speed.
- To increase or decrease depth of field select the pair with the smallest or largest aperture.

**Using Program Shift**
1. Set the Mode dial P (for Program AE) then press the shutter button halfway down, and release it to activate metering.
2. Turn the Main Dial to scroll through pairs of aperture/shutter speed combinations and select the pair you want to use. If the aperture or shutter speed readout don’t blink the exposure is OK. (See Tips in this topic.)
3. Press the shutter button all the way down to take the photo.
   - The shifted program setting is cancelled automatically if you pause a few seconds before taking another photo.
   - If you take another picture before metering turns off, you use the shifted settings. You can retain the shifted setting by holding the shutter button halfway down. When ready, press it all the way down to take the picture.

One reason to use program shift is that it prevents you from choosing settings that exceed your camera’s exposure limits. In shutter-priority (Tv) and aperture-priority (Av) modes it’s possible to select a setting that can’t be matched. For example, in aperture-priority (Av) mode, you may pick an aperture that’s so large the camera doesn’t have a shutter speed that’s fast enough to prevent overexposure. Although shutter-priority (Tv) and aperture-priority (Av) modes warn you when this happens, you won’t always notice the warning. Here are some of the situations you avoid when using programmed mode.

<table>
<thead>
<tr>
<th>When you select a...</th>
<th>There may not be...</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large aperture</td>
<td>A shutter speed that’s fast enough</td>
<td>Overexposure</td>
</tr>
<tr>
<td>Small aperture</td>
<td>A shutter speed that’s slow enough</td>
<td>Underexposure</td>
</tr>
<tr>
<td>Slow shutter speed</td>
<td>An aperture that’s small enough</td>
<td>Overexposure</td>
</tr>
<tr>
<td>Fast shutter speed</td>
<td>An aperture that’s large enough</td>
<td>Underexposure</td>
</tr>
</tbody>
</table>

**Tips**
- If a usable aperture/shutter speed combination isn’t available in one of the automatic shooting modes, the shutter speed or aperture reading in the viewfinder or on the LCD panel blinks. In this table you can see what to do when this happens. To increase exposure turn the Main or Quick Control dials counter clockwise, To decrease exposure turn them clockwise. You can also increase or decrease the ISO speed.

<table>
<thead>
<tr>
<th>Shooting Mode</th>
<th>Aperture blinking</th>
<th>Shutter speed blinking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smallest</td>
<td>Largest</td>
</tr>
<tr>
<td>Tv</td>
<td>Decrease exposure</td>
<td>Increase exposure</td>
</tr>
<tr>
<td>Av</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P</td>
<td>Decrease exposure</td>
<td>Increase exposure</td>
</tr>
</tbody>
</table>

- At the extreme end of a shutter speed or aperture’s range there may only be one available pair of settings in program shift.
- Program shift works much like AE lock in that once you turn it on the effective exposure is locked even though you can change the aperture and shutter speed. The exposure unlocks when you take a picture or cancel program shift.
- Program shift cannot be used with flash.
Resources to Explore

1. Program shift uses Exposure Values (EV) which are all of the shutter speed and aperture pairs that give the same exposure. For example, the shutter speed 1/250th at f/8 has the same EV as 1/125th at f/11. Search the Internet for the term “exposure value” to learn more.

Seeing for Yourself

1. Turn on Live View and set the shooting mode to Program AE (P). In a bright setting use program shift to change the aperture/shutter speed pairs while noticing how the brightness of the image doesn’t change on the monitor because you are not changing the exposure.

2. Arrange a newspaper or ruler on the floor or tabletop and photography it at a 45° angle. Pick a line as your point to focus on. Take two pictures as follows and then compare the images to see if the second has more depth of field:
   - Using program shift set the exposure to the pair with the fastest shutter speed and largest aperture and take the first picture.
   - Using program shift set the exposure to the pair with the slowest shutter speed and smallest aperture and take the second picture.

3. Find a scene with constant motion, such as a steady stream of traffic. Take two pictures as follows and then compare the images to see if the second has more blur:
   - Using program shift set the exposure to the pair with the fastest shutter speed and largest aperture and take the first picture.
   - Using program shift set the exposure to the pair with the slowest shutter speed and smallest aperture and take the second picture.

4. With the camera in Program AE (P) shooting mode and the flash off press the shutter button halfway down as you watch the monitor to see how the camera indicates the aperture and shutter speed it has selected. Then, take the camera into a dark closet and do the same to see how it indicates it can’t find an exposure that works.

5. Open Target 23 Bouncing Ball in Appendix A and click one of the links to display a bouncing ball. Using program shift set the exposure to the pair with the fastest shutter speed and then the slowest and use these two settings to photograph the ball. Does one pair show any subject movement? Try the same thing with the ball bouncing at the other two speeds.

If you want to be sure you are ready to capture fleeting moments such as this swallowtail butterfly with its wings fully spread, Program AE (P) is a good choice because you don’t have to worry about settings unless you want to.
Topic 3–5. Shooting Modes—Shutter-Priority (Tv)

When controlling motion is the most important goal, you use shutter-priority, what Canon calls time-value (Tv) mode, so you can set the shutter speed directly. Although digital cameras can select any fraction of a second for an exposure, there are a series of settings that have traditionally been used when you set it yourself. These shutter speed settings, called stops, are arranged in a sequence so that each of the traditional settings let in half as much light as the next slowest setting and twice as much as the next fastest. Typical settings are listed in the table that follows. The camera has two additional shutter speeds between each pair of traditional ones so you can adjust exposure in one-third stop increments for finer exposure control.

<table>
<thead>
<tr>
<th>7D Mark II Shutter Speeds (whole stops)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8000</td>
</tr>
<tr>
<td>1/60</td>
</tr>
<tr>
<td>1/4</td>
</tr>
<tr>
<td>15”</td>
</tr>
</tbody>
</table>

As the shutter speed gets slower, the image gets lighter. The reason you don’t usually see this effect in your images is because when you or the camera change the shutter speed in Tv mode, the camera changes the aperture to keep the exposure constant.

Pressing the shutter button halfway down activates metering which then remains activated as long as you are changing the shutter speed, and for four seconds after you stop.

- When metering is on, both the shutter speed and aperture are displayed in the viewfinder and on the LCD panel and when you change the shutter speed, the matching aperture also changes on the display.
- When metering is off, only the current shutter speed is displayed on the monitor and you can’t see either setting in the viewfinder until you press the shutter button halfway down.

Using Shutter-Priority (Tv) Mode

1. With the Mode Dial set to Tv (time value) press the shutter button halfway down and then release it to activate metering and the exposure readouts in the viewfinder and on the LCD panel.
2. Turn the Main Dial to select a shutter speed and if the aperture value isn’t blinking, the exposure is OK. (see Tips in this topic.)
3. Press the shutter button all the way down to take the picture.

The shutter has changed considerably over the years. The earliest cameras, using imaging materials that might take minutes to be properly exposed, came with a lens cap that the photographer removed to begin the exposure and then replaced to end it. As film became more sensitive to light and exposure times became shorter, faster shutters were needed. One kind used a swinging plate while another design used a guillotine-like blade. As the blade moved past the lens opening, a hole in the blade allowed light to briefly reach the film. Today cameras have one of three types of shutters: an iris shutter with blades that pivot to open and close, a focal plane shutter with two fabric curtains that open and close, or an electronic shutter that turns on to start the exposure and off to end it.

A fast shutter speed opens and closes the shutter so quickly a moving subject, such as this amusement park ride, doesn’t move very far during the exposure.
A slow speed allows moving objects to move sufficiently to blur their image on the image sensor.

A fast shutter speed (right) opens and closes the shutter so quickly a moving subject doesn’t move very far during the exposure, a slow speed (left) can allow moving objects to move sufficiently to blur their image.

In addition to using shutter-priority (Tv) shooting mode, you can indirectly control the shutter speed in aperture-priority (Av) mode by changing the aperture and directly control it in Manual (M) mode by changing the shutter speed. For example, to be sure you are always using the fastest possible shutter speed for a given situation, set the camera to aperture-priority (Av) mode and select the aperture needed for depth of field. The camera will then always select the fastest possible shutter speed for that aperture setting.

Shutter speeds are indicated on the camera in different ways. For example, shutter speeds from 8000 to 4 indicate the denominator of the fractional shutter speed. For example, 125 indicates 1/125 seconds. A quotation mark before a whole number, such as 0”5 indicates 0.5 seconds. A quotation mark after a whole number, indicates full seconds. For example, 15” is 15 seconds.

When you are using flash your fastest possible shutter speed is 1/250 because on cameras with focal plane shutters the shutter is only open for a brief instant. If the shutter opens and closes too quickly, it will block part of the sensor when the flash fires. The fastest shutter speed you can normally use is called the flash sync or synchronization speed. To use a faster shutter speed with flash you have to use an external flash that has a high speed sync setting.

Shooting down from an upper level at the Guggenheim Museum froze the people standing still but blurred everyone walking by.
• As you change the shutter speed in Tv mode you don’t see the image get lighter or darker because the camera offsets the change by changing the aperture to keep the exposure constant.

• The range of selectable shutter speeds is from a slow 30 seconds to a fast 1/8000 in one-third stop increments.

• There is a Bulb (B) shooting mode that keeps the shutter open as long as you hold down the shutter button.

• If you can’t get a fast enough shutter speed, increase the camera’s ISO. If you can’t get a slow enough one, use a neutral density filter or lower the ISO.

• The Exposure level increments setting on the Shooting 1 menu tab changes exposure increments from 1/3rd to 1/2 stops.

• When using the built-in flash, the fastest shutter speed you can select is 1/250.

• If the light changes suddenly, the camera automatically overrides your settings for a good exposure if you enable Safety shift on the Shooting 1 menu tab. This setting is discussed on page 00 of your camera’s Instruction Manual.

• When using flash in Av mode, you can fix the shutter speed to prevent a slow shutter speed when photographing in dim light. This will help you avoid blur caused by camera or subject movement. To set it, display the Shooting 1 menu tab, select Flash control and then Flash sync. speed in Av mode to 1/250-1/60 sec. auto or 1/250 sec. (fixed).

• If a usable aperture/shutter speed combination isn’t available in one of the automatic shooting modes, the shutter speed or aperture reading in the viewfinder or on the LCD panel blinks. In this table you can see what to do when this happens. To increase exposure you turn the Main or Quick Control dials counter clockwise, To decrease exposure you turn them clockwise. You can also increase or decrease the ISO speed.

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</tr>
<tr>
<td>P</td>
<td>Decrease exposure</td>
<td>Increase exposure</td>
</tr>
</tbody>
</table>

• When the shutter speed is 1 second or more, noise reduction Long Exposure NR may be performed for the same amount of time that the shutter was open and you cannot take any new images during this processing.

• Street photographers, including Garry Winogrand and Lee Friedlander, shot at 1/1000 to avoid blur in their images.

Resources to Explore

1. Shutter Speed Effect on Exposure illustrates how fast shutter speeds let in less light, and slow shutter speeds let in more. www.photocourse.com/itext/speedseries.

2. Shutter Speed Effect on Motion illustrates how the faster the subject is moving the faster the shutter speed must be to freeze it. www.photocourse.com/itext/shutterspeed.

3. How a Focal Plane Shutter Works at Fast Shutter Speeds illustrates how at fast shutter speeds the focal plane shutter curtains move across the image sensor as a slit “painting” the image as it goes. www.photocourse.com/itext/focalplane.

4. How a Focal Plane Shutter Works at Slow Shutter Speeds illustrates how at slower shutter speeds there is a point at which the entire image sensor is exposed to light. The first curtain opens completely and only then does the second curtain start to close. The fastest shutter speed at which the shutter is fully open is called the flash sync speed. www.photocourse.com/itext/sync.

5. How an Electronic Shutter Works illustrates how an electronic shutter turns on the image sensor to begin recording an exposure and turns it off to end it. In between those two points the image builds up as light is captured by the sensor. Because these shutters have no moving parts they are less expensive. However, they can also be very precise and accurate in more expensive versions. www.photocourse.com/itext/shutterelectronic.

Seeing for Yourself

1. Practice setting the shooting mode to shutter-priority (Tv) and selecting a shutter speed.

2. Since your camera let’s you release the shutter when there is no lens on the camera you can watch your shutter operate. In a dust free and breezeless environment remove the lens. In Tv mode set the shutter speed to various settings, including very slow, and press the shutter button as you watch the way the
shutter works. Since it’s a focal plane it has two black curtains that move vertically—one to start the exposure and one to end it.

3. Scroll through images in playback mode, pressing INFO if necessary, to display the shutter speed used to capture them. Are there any where you think a faster or slower shutter speed might have improved the image?

4. With the camera in shutter-priority (Tv) shooting mode photograph constantly moving subjects, such as passing cars, at various shutter speeds to see how fast a shutter speed you need to freeze motion. To check sharpness enlarge the images in playback mode.

5. In shutter-priority (Tv) mode change the shutter speed while watching the aperture setting change on the LCD panel or in the viewfinder. (You may have to press the shutter button halfway down to see the current setting.) In Live View does this change have any effect on the image displayed on the monitor?

6. In a dark room set the camera to shutter-priority (Tv) and a shutter speed of 1 or 2 seconds. Use the self timer to start an exposure and stand in front of the camera as you draw in the air with a small flashlight without pointing it directly at the lens, or use an illuminated cell phone or other small light. Check your results and you should find light trails in the image. Try changing your distance, shutter speed and pattern to refine your results.

7. With the camera in shutter-priority (Tv) shooting mode, and the flash off, press the shutter button halfway down as you watch the viewfinder to see how the camera indicates the aperture it has selected. Then, take the camera into a dark closet and do the same to see how it indicates it can’t find an aperture that works.

8. In his autobiography Ansel Adams quotes a friend that “The two most beautiful sounds in the world are the opening and closing click of the camera shutter”. Set your camera to a variety of shutter speeds and see at what speed you hear two distinct clicks instead of one. Between those two clicks an image is created.

9. Display Target 23 Bouncing Ball in Appendix A full-screen. Set your camera to shutter-priority (Tv) mode and try freezing the ball with shutter speeds at each of the three speed settings. www.photocourse.com/itext/tracking/tracking.gif.

If you think long exposures create problems look at this photograph from the Hubble space telescope that took over two million seconds of exposure time and is the deepest image of the Universe ever made. Credit: NASA, ESA, G. Illingworth, D. Magee, and P. Oesch (University of California, Santa Cruz), R. Bouwens (Leiden University), and the HUDF09 Team.
Here a shutter speed of 1/1000 was fast enough to freeze not just the Navy planes flying overhead but also their propellers.

A fast shutter speed freezes a motorcycle on a Salem, Massachusetts Halloween ride.
A snowboarder goes airborne and is frozen in the air by a fast shutter speed.

A fast shutter speed freezes a speedboat.

Helicopter with blades frozen by a fast shutter speed.

Beaver frozen as it swims past.
When controlling depth of field is the most important goal, you use aperture-priority (Av), which Canon calls aperture value, mode so you can set the aperture directly. Aperture settings, called f/stops, indicate the size of the aperture opening inside the lens. In the traditional series of f/stops (shown below), each full stop lets in half as much light as the next larger opening and twice as much light as the next smaller opening. The camera has two additional apertures between the traditional f/stops so you can adjust exposure in one-third stops for finer exposure control. The range of apertures you have to choose from, including the maximum aperture (the widest opening), depends on the lens you are using. Lenses with large maximum apertures are better when the light is dim, or you are photographing fast moving subjects because they let you use faster shutter speeds. Their only disadvantages are that they are generally heavier and cost more than slower lenses.

As the aperture number gets smaller (for example, from f/8 to f/5.6) the aperture opening gets larger and the image gets lighter. The reason you don’t usually see this effect in your images is because when you or the camera change the aperture, the camera changes the shutter speed to keep the exposure constant.

Notice that as the f/stop number gets larger (f/4 to f/5.6, for example), the lens opening gets smaller. This may be easier to remember if you think of the f-number as a fraction: 1/8 is less than 1/4, just as the size of the f/8 lens opening is smaller that the size of the f/4 opening.

Pressing the shutter button halfway down activates metering which then remains activated as long as you are changing the aperture, and for four seconds after you stop.

- **When metering is on**, both the aperture and shutter speed are displayed in the viewfinder and on the LCD panel and when you change the aperture the matching shutter speed also changes on the display.
- **When metering is off**, only the current aperture is displayed on the LCD panel and you can’t see either setting in the viewfinder until you press the shutter button halfway down.

### Using Aperture-Priority (Av) Mode

1. With the Mode Dial set to Av (aperture value), press the shutter button halfway down and then release it to activate metering and the exposure readouts in the viewfinder and on the LCD panel.
2. Turn the Main Dial to select an aperture and if the shutter speed isn’t blinking, the exposure is OK. (see Tips in this topic.)
3. Press the shutter button all the way down to take the picture.

How wide you can open the aperture depends on the lens’s maximum aperture—its widest opening. The term “fast lens” usually applies to lenses that can be opened to a wide maximum aperture for the focal length. For example, a lens with a maximum aperture of f/2.0 opens wider, and is faster, than a lens with a maximum aperture of f/3.5. Faster lenses are better when photographing in dim light or photographing fast moving subjects. On most zoom lenses the maximum aperture changes as you zoom the lens. It will be larger when zoomed out to a wide angle, and smaller when zoomed in to enlarge a subject. Lenses will be marked with their aperture range such as f/2.0 for a prime lens or f/2.0–5.6 for a zoom lens.

In cameras with interchangeable lenses the aperture is usually a series of overlapping leaves located between the glass elements.
A large aperture decreases depth of field so the background is soft.

A small aperture increases depth of field so foreground and background are sharp.

In addition to using aperture-priority (Av) shooting mode, you can indirectly control the aperture in shutter-priority (Tv) mode by changing the shutter speed and directly control it in Manual (M) mode by changing the aperture. For example, to be sure you are always using the largest possible aperture in a given situation, set the camera to shutter-priority (Tv) mode and pick the shutter speed you need to freeze or blur motion. The camera will then always select the largest possible aperture for that shutter speed.

A variety of designs in the past century and a half have enabled photographers to change the size of the lens opening. An early version of the iris diaphragm used in today’s cameras was used as early as the 1820s by Joseph Nicephore Niepce, one of the inventors of photography. Waterhouse stops, used in the 1850s, were a series of blackened metal plates with holes of different sizes cut in them. To change apertures the photographer chose the appropriate plate and slid it into a slot in the lens barrel. With wheel stops, different size apertures were cut into a revolving plate. The photographer changed the size of the aperture by rotating the plate to align the desired opening with the lens.

**Tips**

- As you change the aperture in Av mode you don’t see the image get lighter and darker because the camera offsets the change by selecting a new shutter speed to keep the exposure constant.
- If you can’t get a small enough aperture, increase the ISO. If you can’t get a large enough one, use a neutral density filter.
- The Exposure level increments setting on the Shooting 1 menu tab changes exposure increments from 1/3rd to 1/2 stops.
- If the light changes suddenly, the camera automatically overrides your settings for a good exposure if you enable Safety shift on the Shooting 1 menu tab.
- To get smaller apertures, increase the ISO. To get larger apertures, use a lower ISO or a neutral density filter.
- Apertures are sometimes referred to as Av for aperture value.
- The range of apertures varies from lens to lens. The variation is most noticeable at the largest apertures.
- If a usable aperture/shutter speed combination isn’t available in one of the automatic shooting modes, the shutter speed or aperture reading in the viewfinder or on the LCD panel blinks. In this table you can see what to do when this happens. To increase exposure you turn the Main or Quick Control dials counter clockwise, To decrease exposure you turn them clockwise. You can also increase or decrease the ISO speed.
Chapter 3 Setting the Shutter Speed and Aperture

Section 3-6. Shooting Modes—Aperture-Priority (Av)

<table>
<thead>
<tr>
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- When using flash in Av mode, you can fix the shutter speed to prevent a slow shutter speed when photographing in dim light. This will help you avoid blur caused by camera or subject movement. To set it, display the Shooting 1 menu tab, select Flash control and then Flash sync. speed in Av mode to 1/250-1/60 sec. auto or 1/250 sec. (fixed).

- If you change lens or add lens elements while in manual mode you effect the exposure. You can compensate for the change by automatically adjusting your shutter speed or ISO. To do so display the Custom functions 1 menu tab and select Same expo. for new aperture and set it to ISO or Tv. This is described on page 437 of your camera’s Instruction Manual.

- Normally the aperture is wide open when you compose images. This ensures that the image in the viewfinder is bright but makes it impossible to preview depth of field. To stop the aperture down to the size it will be when you take the picture, and preview depth of field, press the camera’s depth of field button. This is especially effective in Live View.

Resources to Explore

1. The Standard Series of Apertures illustrates how as the aperture gets larger, the f/number gets smaller. For example, f/2 is larger than f/16. In the aperture series f/16, f/11, f/8, f/5.6, f/4, f/2.8 and f/2 each setting lets in twice as much light as the previous aperture and half as much as the next. [www.photocourse.com/itext/aperture](http://www.photocourse.com/itext/aperture).

2. Apertures Effect on Exposure illustrates how smaller apertures let in less light and, if the shutter speed doesn’t change, as the aperture gets larger it lets in more light and the picture gets lighter. [www.photocourse.com/itext/exposureseries](http://www.photocourse.com/itext/exposureseries).

3. Aperture and Depth of Field illustrates that as the aperture gets larger, the depth of field gets shallower and objects in the foreground and background become softer. Here the camera is focused on the gray building so that’s where the plane of critical focus is. As the aperture is opened one stop at a time, the depth of field in front and behind that plane gets shallower and shallower. [www.photocourse.com/itext/DOF](http://www.photocourse.com/itext/DOF).

4. Search your camera’s user guide to see if program shift is available in aperture-priority (Tv) shooting mode and, if so, how to use it.

3. Search your camera’s user guide to see how you select aperture-priority (Av) shooting mode and how you change the aperture.

Seeing for Yourself

1. Set the camera to aperture-priority (Av) shooting mode and while looking into the front of the lens change the aperture setting as you watch the aperture change size. On an SLR you may have to press the depth of field preview button each time you want to see the change.

2. Display and scroll through images in playback mode and look at the aperture used to capture them. Are there any where you think a larger or smaller aperture might have improved the image?

3. Photograph scenes using various apertures to see how small an aperture has to be to give you the depth of field you want. For best results zoom in and get close to the subject with a distant background. To check sharpness enlarge the image in playback mode.

4. In aperture-priority (Av) mode change the aperture while watching the shutter speed setting change on the LCD panel or in the viewfinder. (You may have to press the shutter button halfway down to see the current setting.) Does this change have any effect on the image displayed on the monitor in Live View?

5. Arrange a newspaper or ruler on the floor or tabletop and photograph it at a 45° angle. Pick a line as your point to focus on. Take two pictures of it, one with the camera set to the largest aperture and one set to the smallest. Compare the images to see if the second has more depth of field.

6. With the camera in aperture-priority (Av) shooting mode, and the flash off, press the shutter button halfway down as you watch the LCD panel and viewfinder to see how the camera indicates the shutter speed it has selected. Then, take the camera into a dark closet and do the same to see how it indicates it can’t find a shutter speed that works.
Great depth of field keeps everything sharp from the foreground to the background.

A shallow depth of field can make part of an image stand out sharply against a softer background. This emphasizes the sharpest part of the image.

A sand sculpture of Grocho Marx is sharp from near to far.
When you want total and absolute control over exposures, you can switch to Manual (M) shooting mode. In this mode, you manually select both the shutter speed and aperture setting. Since automatic exposure combined with exposure compensation is so easy to use, most photographer’s only resort to manual mode in those rare situations where other modes can’t give them the results they want. For example, you may use this mode when photographing a series of images for a panorama or animated GIF where you don’t want the exposure to change at all from one shot to the next.

When you press the shutter button halfway down, an exposure level indicator on the right side of the viewfinder shows you how much you are under (-) or over (+) the exposure calculated by the camera. You use this scale and the symbols on it to guide you in setting the exposure manually. For example:

- To lighten the image you set it to a + value by turning the Main or Quick Control dial counter-clockwise.
- To darken an image set it to a – value by turning the Main or Quick Control dial clockwise.
- To use the camera’s recommended setting, set it to 0.

### Using Manual (M) Mode

1. With the Mode Dial set to M (Manual), press the shutter button halfway down and then release it to activate the vertical exposure level indicator on the right side of the viewfinder that shows how much you are over or under the recommended exposure.
2. Turn the Main Dial to select a shutter speed and the Quick Control Dial to select an aperture as you watch the Vertical exposure level indicator ( ■ ) on the right side of the viewfinder.
   - If the exposure level indicator is centered ( ▲ ), you’re set to the exposure recommended by the camera.
   - If the exposure level indicator is on the minus ( ▼ ) side of the scale, you may be underexposing and darkening the image. To lighten it, select a slower shutter speed or larger aperture.
   - If the exposure level indicator is on the plus side ( ▲ ) you may be over-exposing and lightening the image. To darken it, select a faster shutter speed or smaller aperture.
3. Press the shutter button all the way down to take the picture.

### Tips

- In Manual (M) shooting mode pressing AE lock (*) locks in the current ISO setting.
- The exposure level indicator doesn’t indicate how far under or over the recommended exposure you are unless metering is on. To turn it on, press and release the shutter button.
- If you recompose the scene or zoom the lens after setting the aperture or shutter speed these settings may need to be adjusted.
- If the ISO is set to Auto and the speed changes, the camera, and not you, determines what it thinks is a good exposure. To prevent this so only your own settings are used, take ISO off Auto.
- When you use the Manual (M) shooting mode there may be times when you want to use a specific aperture and shutter speed. In those situations you can adjust the exposure by using the ISO setting to lighten or darken the image. To do so, just press the ISO button and then turn the Main dial. In Live View you can see the image lighten or darken as you change settings. At any ISO setting...
other than Auto the horizontal exposure level indicator is not displayed but the vertical one is.

• It may surprise you how many famous photographers, who’s cameras were manual, would set their exposure using instruction sheets packaged with the film they used. Today you can manually set it in unusual lighting by trial and error using the image on the monitor and its histogram in playback or Live View mode.

A typical instruction sheet that was packaged with film.

• When the ISO is set to Auto in Manual (M) shooting mode, pressing the AE Lock button (*) locks the ISO speed.

**Resources to Explore**

1. Search the Internet for “7D Mark II exposure level indicators” to see if there is any on-line discussions bout these.
2. Search the Internet for “manual exposure mode” to learn more about this important shooting mode.

**Seeing for Yourself**

1. Set the camera to Manual (M) shooting mode and turn on Live View. Then adjust the shutter speed and aperture while watching the image on the monitor change. Try to get the correct exposure at a number of different settings.

2. In the days of film, before built in meters and autoexposure, the first rule of exposure was known as The Rule of 16. It states that in full sun and with the aperture set to f/16 the shutter speed should be 1 over the ISO. For example, if the ISO was 100 the shutter speed should be 1/100—or as close to that as you could get. On a sunny day try these settings in Manual (M) mode and see if they work as promised.

Manual exposure mode is ideal when the lighting is fairly constant and especially when light on the main subject is constant but the background is constantly changing.
To get exposures at night, you can use the Bulb (B) shooting mode. Bulb makes it possible to capture light trails from moving cars and star trails as the Earth rotates under a canopy of stars. When in this mode, the timer goes to 999 seconds as long as you hold down the shutter button and moving lights paint lines in the image. To avoid blur from camera shake, you must use a tripod or other secure support. Keep in mind that when using bulb, you can’t see through the viewfinder while the exposure is being made. Also long exposures add noise to an image but you can turn on Long exposure noise reduction on the Shooting 3 menu tab to reduce it as described in Topic X–Y.

**Using Bulb Exposures**

1. Set the Mode Dial to B (Bulb), then turn the Main or Quick Control Dial to select an aperture.
2. Hold down the shutter button for as long as you wish. A timer is displayed on the LCD panel to guide you and counts up to 999 seconds.

You can preset the time the shutter remains open using the Bulb timer setting on the Shooting 4 menu tab.

**Using the Bulb Timer**

1. Set the Mode Dial to B (Bulb), press MENU and select Bulb timer on Shooting 4 menu tab.
2. Turn the Quick Control Dial to highlight Enable and press the INFO button to set a time in hours, minutes and seconds.
3. Press SET to select one of the settings, turn the Quick Control dial to set it, then press SET again. Repeat this for each of the three settings.
4. When finished select OK and press SET to return to the menu.

**Tips**

- You might want to switch to Tv (shutter-priority) or M (Manual) mode so you can use shutter speeds as slow as 30 seconds.
- Display the Shooting 3 menu tab and set High ISO speed noise NR to High.
- To stop the Bulb timer while keeping it enabled, press the shutter button all the way down
- If you combine bulb exposures, the self-timer, and mirror lockup, hold down the shutter button during the entire self-timer delay time and bulb exposure time). If you release it before the timer ends, there will be a shutter-release sound but no picture is taken.
- If the camera has trouble focusing, switch to manual focus.
- Pressing the LCD Panel Illumination button lights the LCD panel so it’s readable in the dark. It turns off after 6 seconds of inactivity. Turning the Mode Dial or pressing any shooting related button extends it.

- If the ISO is set to Auto ISO, the speed will be ISO 400.
- For a bulb exposure, if you use both the self-timer and mirror lockup instead of the bulb timer, keep pressing the shutter button completely (self-timer delay time + bulb exposure time). If you let go of the shutter button during the self-timer countdown, there will be a shutter-release sound, but no picture will be taken. If you use the bulb timer under the same shooting conditions, you need not hold down the shutter button completely.
- Do not point the camera at the sun on a sunny day or at an bright artificial light source. Since the shutter is open for a long time these may damage the image sensor or other components.
- Instead of using the Bulb timer you can use the remote switch RS-80N3 or Timer Remote Controller TC-80N3 or RC-6 to lock the shutter open for long exposures.

**Resources to Explore**

1. Search the Internet for “photographing star trails” to learn how this is done.
2. Search the Internet for “bulb mode” for ideas on how to use this mode.

**Seeing for Yourself**

1. In a fairly dark room set the Bulb timer to 2 minutes, then take photos at both the largest and smallest aperture. See if you can find an aperture setting and time that gives you a good exposure. What is the noise like in the images? Try it with and without long exposure noise reduction.
2. Locate a stream of traffic at night and use Bulb (B) mode to capture trails created by the moving cars.
Topic 3–9. Shooting Modes—Custom (C1–C3)

Custom (C1 to C3) shooting modes let you store P, Tv, Av, or M mode settings that you use over and over again. This is as simple as setting the camera the way you want it and then selecting the menu command that saves the current settings to the custom mode. You can then instantly access the settings at any time just by turning the Mode dial. For example, you can save one group of settings to capture macro subjects and one to capture action scenes. Once you set a custom mode it always reverts to your saved settings when you select that mode. The only way to change the settings is to repeat what you did initially—change the settings and then save them again. One of the best things about these custom settings is that they are not reset when you use the command that resets other settings to their factory defaults unless you specify that they be reset with Clear settings on the menu.

Using Custom C1–C3 Modes

1. In any shooting mode other than Scene Intelligent Auto, press MENU and display the Set-up 4 menu tab.
2. Select Custom Shooting mode (C1–C3) and press SET.
3. Select either of the following and then press SET:
   • Register Settings to save the current settings
   • Clear settings to clear settings
4. Select the custom mode you want to save the settings to or clear them from and press SET.

• The camera remembers saved settings even when turned off, and restores them the next time you select on of the C1–C3 modes again. Even settings that are normally returned to their defaults when the camera is turned off are remembered.
• The settings saved in C modes have no effect on other shooting modes.
• If you change any settings while using a C mode and want to preserve them you have to save the settings again. When you do so the new settings overwrite any settings previously saved to the selected C mode. If you don’t save your settings they are lost when you turn off the camera or switch to another mode.

Tips

• The settings you can assign to one of the C modes include the following:
  • Shooting mode P, Tv, Av and M
  • Settings you can change in the above modes
  • Shooting menu settings
  • Zoom setting
  • Manual focus setting
  • Macro mode
  • My Menu settings

While hiking, I have C1 set to capture macro images and C2 set to capture action. I leave the camera set to C2 as I hike so if I encounter something unexpected I have my best chance of capturing it. If I encounter a subject that is stationary, I can switch to the C1 mode, or take time to change other settings.

Resources to Explore

1. Search the Internet for “Canon Custom shooting modes” to learn more about how useful these modes can be.

Seeing for Yourself

1. Set up a custom shooting mode (C1) using the following settings for close-up photography: Shooting mode—Program AE (P), Image Quality—RAW, Drive mode—2 second timer, and ISO—400.
Chapter 3 Setting the Shutter Speed and Aperture

Topic 3–10. Shutter Speed—Sharpness

The aperture and its effect on depth of field is not the only way to control sharpness in a photo. The shutter speed and its effect on sharpness is another. Blur can be deliberately created when the subject or camera moves during an exposure and can be part of the message of the photograph. For example, the immobility of a frozen figure can be made more apparent by blurring people moving in other parts of the scene.

Blur in an image is caused when a subject focused onto the image sensor moves when the shutter is open. To show a moving subject sharply, the shutter needs to open and close before the image on the sensor moves a significant amount. In other words, you need to use a fast shutter speed. But just how fast is fast enough? The answer depends on several factors so you can’t always predict how motion will be portrayed in the final photograph. To improve your odds of getting a good photo, use different settings and take more than one shot so you have several to choose from. Try shooting from different angles, or perhaps wait for a pause in the action or its peak. Just be aware that sharpness can be hard to evaluate on the camera’s monitor so enlarge it as much as possible. Better yet, transfer it to a computer and evaluate it there.

<table>
<thead>
<tr>
<th>Shutter Speed Needed</th>
<th>Faster</th>
<th>Slower</th>
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<tbody>
<tr>
<td>Speed of Subject</td>
<td>![Rabbit]</td>
<td>![Turtle]</td>
</tr>
<tr>
<td>Direction of Movement</td>
<td>![Horizontal]</td>
<td>![Vertical]</td>
</tr>
<tr>
<td>Focal Length or Distance to Subject</td>
<td>![Camera 1]</td>
<td>![Camera 2]</td>
</tr>
</tbody>
</table>

The shutter speed needed to control the sharpness of a moving object is determined by the subject’s speed, direction of movement, and distance.

### Speed of Subject

The faster a subject is moving, the faster the shutter speed you need for a sharp image. However, it’s not the speed of the subject in the real world that determines blur. It’s how far the subject moves on the image sensor while the exposure is being made. This depends not just on the subject’s actual speed, but also
on the direction of its movement, its distance from the camera, and the focal length of the lens.

### Direction of Movement

When the shutter is open, a subject moving parallel to the image sensor crosses more of the pixels on the sensor and is more blurred than a subject moving directly toward or away from the camera. This is why you can use a slower shutter speed to sharply photograph a subject moving toward, or away from you, and not the same subject moving from one side of the scene to the other.

On this speeding train, the part closest to the camera looks the most blurred while the farthest part looks sharper. Since all parts of the train are moving at the same speed, this shows how distance affects blur.

### Distance to Subject and Focal Length of Lens

If a subject is close to the camera, even slight movement is enough to cause blur. A subject—or part of one—far from the camera can move a considerable distance before its image on the image sensor moves very much. The focal length of the lens can also affect the apparent distance to the subject. Increasing the focal length of your lens—for example, zooming in on a subject—has the same effect on blur as moving closer. Increasing the focal length not only magnifies the subject but also its movement, increasing the likelihood it will be blurred.

### Increasing Sharpness

To increase the sharpness of moving subjects, here are some things you can try:

<table>
<thead>
<tr>
<th>INCREASING SHARPNESS</th>
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<tbody>
<tr>
<td>• Photograph fast moving subjects heading toward or away from you.</td>
</tr>
<tr>
<td>• Move farther back from the subject or use a shorter focal length lens.</td>
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<tr>
<td>• Switch to shutter-priority (Tv) mode and select a fast shutter speed such as 1/500 or even 1/1000.</td>
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<tr>
<td>• Increase the ISO so you can select a faster shutter speed although this may add some noise to the image.</td>
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<tr>
<td>• Photograph in bright light or use flash so you can use a faster shutter speed.</td>
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</table>

### Things to Try

If your photos aren’t as sharp as you want them to be, you can analyze them to see what went wrong.

• **Focus.** If nothing in your image is sharp or if your central subject is not sharp but other parts of the photograph are, your camera was improperly focused.

• **Depth of Field.** If your central subject is sharp but the background or foreground is less so, you may not have used a small enough aperture to get the depth of field you wanted.

• **Camera Movement.** If the image is blurred all over, with no part sharp, the camera moved during the exposure. Some dots appear as lines and edges are blurred because the image was “painted” onto the moving image sensor.

• **Subject Movement.** When some of the picture is sharp but a moving subject appears blurred, your shutter speed was too slow.

### Tips

• Using continuous mode lets you run off a series of photos of the same action so you can select the best one.
To be sure you have the fastest shutter speed in a given situation, switch to aperture-priority (Av) mode and select the largest aperture that will give you the depth of field you need. The camera will then automatically select the fastest possible shutter speed for that aperture.

To capture action that happens suddenly, anticipate it by pointing the camera toward where the action will occur and pressing the shutter button halfway down to lock focus and exposure on something at the same distance. Hold the button down until the action happens and you'll be able to get a shot off without any delay. You can also use AE Lock to set focus and exposure on different parts of the scene.

Slow sync flash lets you freeze part of a scene while blurring the rest.

Resources to Explore

1. **Distance and Sharpness** uses a camera’s movie mode to capture the scene from the window of a car as it passes St Louis. Notice how things in the foreground zip by and are blurred while those in the background move by in a stately fashion and are relatively sharp. [www.photocourse.com/itext/distance](http://www.photocourse.com/itext/distance).

2. **The Shutter and Sharpness** illustrates how the speed of the subject determines which shutter speeds freeze or blur the action. When trying to freeze action, the faster the subject is moving the faster the shutter speed must be. [www.photocourse.com/itext/shutterspeed](http://www.photocourse.com/itext/shutterspeed).

Seeing for Yourself

1. To visualize the effects of distance on blur, look out the side window of a moving vehicle (but not when you’re driving). The objects you pass in the foreground seem to fly by while those on the horizon don’t seem to move at all. Looking out the window with your camera try various focal lengths to see how objects appear to move by faster or slower.

2. To visualize the effects of the direction of movement turn on Live View and move the camera back and forth toward and away from the scene. Notice how little the displayed scene changes. Now move the camera slightly side to side and see how much greater the change is. This demonstrates why you can use a slower shutter speed when photographing subjects moving toward or away from you.

3. Find a scene such as a busy intersection where you can photograph subjects moving toward and parallel to you at roughly the same speed and distance. Find a shutter speed that is just fast enough to freeze a subject coming toward you. Now use that same shutter speed to photograph a subject moving parallel to you. Is the second photos also free of subject blur?

4. To visualize how the speed of the subject influences blur open Target 23 Bouncing Ball. Try finding a shutter speed that freezes the SLOW speed and then use the same shutter speed with the MEDIUM and FAST speeds to see if either of them has blur. Keep trying until you find a shutter speed that freezes only the SLOW speed while the other speeds blur.

A fast shutter speed caught this osprey in flight.
Panning the camera to follow a moving subject produces an image where the subject is relatively sharp against a blurred background. Your movement should be smooth and controlled, so begin to pan the camera before the subject appears in your viewfinder or on your monitor. Smoothly depress the shutter button as you follow the subject, keeping it in the same position in the viewfinder or on the monitor. Follow through as you would in golf or tennis. Results are quite unpredictable and panning takes practice so take as many images as you can.

A vulture captured flying through Letchworth gorge in New York State with the background blurred slightly from panning.

Here are tips to help you get better results:

- Use AI-Servo AF and 65-point automatic selection AF so you have a better chance of achieving and maintaining focus.
- Try blurring images in low-light situations. In bright light, the shutter will open and close too fast.
- Switch to shutter-priority (Tv) mode and select a slow shutter speed so the shutter is open long enough for the background to be blurred. If it’s dark enough you may want to use Bulb (B) shooting mode so you can keep the shutter open as long as you hold the shutter button pressed all the way down. This also makes it hard to repeat the exact same effect.
  - Turn off the flash or use slow sync flash when trying to blur nearby subjects.
  - Use a neutral density filter, that blocks part of the light entering the camera, to get a slower shutter speed.

**Tips**

- To be sure you have the slowest possible shutter speed in a given situation switch to aperture-priority (Av) mode and select the smallest possible aperture that gives you the depth of field you need. The camera will then select the slowest possible shutter speed for that aperture.
  - If you zoom a lens during a long exposure, while holding the camera steady, you will get an interesting form of blur.
  - Since focus and exposure lock when you press the shutter button halfway down, you can control where focus and exposure are set by locking them on something in the scene before you begin your pan.
  - Some tripods can be leveled so you can swing the camera through an arc without it moving up and down.
  - As you pan, it’s ideal if some element in the viewfinder, such as a marking for an AF area, can be aligned with the horizon or other horizontal element so your pan is level without an excess of up and down motion.

**Resources to Explore**

1. Search the Internet for images using the phrase “panning the camera”.
2. Search the Internet for “tripod leveling base”.
3. Search the Internet for “panning a ball head”.

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Panning the camera to follow a moving subject produces an image where the subject is relatively sharp against a blurred background. Your movement should be smooth and controlled, so begin to pan the camera before the subject appears in your viewfinder or on your monitor. Smoothly depress the shutter button as you follow the subject, keeping it in the same position in the viewfinder or on the monitor. Follow through as you would in golf or tennis. Results are quite unpredictable and panning takes practice so take as many images as you can.

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**Resources to Explore**

1. Search the Internet for images using the phrase “panning the camera”.
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Seeing for Yourself

1. Set the camera to shutter-priority (Tv) shooting mode and select a slow shutter speed. (You may have to wait until dusk or dawn to get a slow enough speed or use a neutral density filter). Find a busy street and photograph passing cars while panning along with them using different shutter speeds. Your goal is to capture a relatively sharp car against a blurred background. Compare the results on the camera’s monitor or on a computer. Did one shutter speed work better than the others? Generally you’ll find that the faster you pan the faster the shutter speed can be and still get blur. Continue practicing until you get good at capturing this kind of photograph.

2. Try panning fast moving objects from different distances and using different focal lengths to see what effects these have.

3. In a room with a few lit table lamps or other lights, and dark enough to get shutter speeds between 1/30 and 1 second, set the camera to shutter-priority (Tv) shooting mode. Pan the camera from side to side as you smoothly press the shutter button to take a picture. Check the results to see how much blur your image has, then try different settings to increase or decrease the effect.

4. Use a slow shutter speed while shooting out of the side window of a car (with someone else driving) to see how the scene blurs. Then photograph a car or motorcycle in an adjacent lane moving at the same speed you are. Find a shutter speed that makes the car relatively sharp against a blurred background.

5. Use a slow shutter speed at dawn, dusk or night to pan a scene full of colorful lights—maybe a store front with neon signs. Try level panning and also move the camera in a circle, zig zag or other pattern. The lights should leave trails in the image.

While on an amusement park ride you can shoot others moving at the same speed as you are so they are sharp but the background is blurred.
Many of the concepts and techniques you use to blur images with camera movement also work when the camera is steady and the subject is moving. The big difference is that when capturing subject blur, the camera is usually on a tripod. Your settings, especially the shutter speed, then allow a moving subject, such as water or car lights, to paint its image on the sensor, conveying motion.

In the early morning and late evening you can set the camera on a tripod and using a very long exposure capture light trails from moving vehicles.

The look of falling water is greatly affected by the shutter speed used to capture it as in this slow shutter speed shot of a waterfall in Yosemite National Park.
Chapter 3 Setting the Shutter Speed and Aperture

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TOPIC 3–12. SHUTTER SPEED—SUBJECT MOTION BLUR

Conveying Motion

- Try blurring images in low-light situations. In bright light, the shutter will open and close too fast.
- Use shutter-priority (Tv) or program shift in Program AE (P) mode to select a slow shutter speed.
- Use a neutral density filter to get a slower shutter speed.
- When panning with a moving subject, use AI Servo AF mode to keep the image focused as long as you hold the shutter button halfway down.

Tips

- To get the slowest possible shutter speed in a given situation, use aperture-priority (Av) shooting mode and select the smallest aperture, or the one that gives you the depth of field you need. The camera will then automatically select the slowest matching shutter speed.
- For very long shutter speeds you can switch to Bulb (B) shooting mode. The shutter stays open as long as you hold down the shutter button but this may cause slight camera movement. You can prevent this by using a bulb timer or a remote control of some kind.

Resources to Explore

1. Search the Internet for “photographing star trails”, to see what images and information you can find.
2. Search the Internet for “photographing light trails”, to see what images and information you can find.
3. Painting a subject with light from a flashlight can give very interesting results. All you need is a long exposure with the camera on a tripod or other stable surface. Search the Internet for “painting photographs with a flashlight” to see examples of this technique and learn more about how you do this.
4. Search the Internet for “Jacques Henri Lartigue Automóvil Delage Gran premio del ACF 1912” taken when he was 18 or so. The image uses blur to convey speed but also has distortions because Lartigue’s camera used a focal plane shutter with a slit that moved from bottom to top so it captured different moments in time on the film. The most obvious effect of this is the distortion of the wheels which convey speed.

Here a fast shutter speed froze everything but the ball which is slightly blurred.
Seeing for Yourself

1. Find a subject such as a windmill, a constant stream of traffic, crowds of people on the sidewalk, or a merry-go-round that’s in continuous motion. Using a tripod photograph it at both slow and fast shutter speeds to see what effect the shutter speed has on subject blur. Then try faster and faster shutter speeds until you find the one that’s fast enough to freeze the action.

2. Just after sunset, set the camera on a tripod at a place where traffic passes by with headlights and taillights on. Use a very long shutter speed or Bulb (B) shooting mode to capture the trails the lights make as their images move across the image sensor.

3. Use a range of shutter speeds to photograph water coming from a faucet. Be creative with the setup and background. For example, have the water pouring into a glass where it sends up bubbles or cascading over a stack of plates. Increase the ISO, if necessary, to get faster shutter speeds to freeze the water.

4. Display Target 23 Bouncing Ball in Appendix A full-screen. Set your camera to shutter-priority (Tv) mode and find shutter speeds that blur the ball to various degrees while it bounces at SLOW, MEDIUM and FAST speeds. [www.photocourse.com/itext/tracking/tracking.gif](http://www.photocourse.com/itext/tracking/tracking.gif).

Here a swan flaps its wings fast enough to blur while the rest of the photo is sharp.

Edward Steichen captured this photograph of the dancer Isadora Duncan. As he relates it “… we went out to a part of the Acropolis behind the Parthenon, and she posed on a rock, against the sky with her Greek garments. The wind pressed the garments tight to her body, and the ends were left flapping and fluttering. They actually crackled. This gave the effect of fire—’Wind Fire’ (Steichen, A Life in Photography, np). Courtesy of Wikimedia Commons.
Chapter 3 Setting the Shutter Speed and Aperture

Topic 3-12. Shutter Speed—Subject Motion Blur

Marrion Post Wolcott photographed out of a moving car window to capture one of the new bridges on the Merritt Parkway between New York and Connecticut. Her shutter speed was fast enough to freeze all motion. Courtesy of the Library of Congress.

On the forth of July flares and the taillights of a passing car provide the reds while an illuminated lighthouse shows in the distant background.

A long lens and a fast shutter speed freeze the water fall in the background and capture how powerful it is.

Here Timothy O’Sullivan uses a slow shutter speed to soften the water going over Shoshone Falls, Snake River, Idaho in 1874. Courtesy of Wikimedia Commons.
Sharpness from foreground to background—or the lack of it—is immediately noticeable when you look at a photograph. In fact, along with focus, it is one of the most important tools in your photographic toolbox. If you are making a portrait, you may want only the person to be sharply focused, but not a distracting background. In a landscape, on the other hand, you may want everything sharp from a foreground flower to a background mountain. Once you understand how to control depth of field, you will feel much more confident when you want to make sure something is—or isn’t—sharp.

Here the camera’s depth of field was just deep enough to keep the Carolina wren in focus. Parts of the image closer to the camera and further away become increasingly less sharp.

If you have ever noticed, photographs have a thin plane of critical focus that determines what appears critically sharp. (See Topic 4–1) However, other parts of the scene in front of and behind this plane appear acceptably sharp. This area of acceptable sharpness is called depth of field or depth of focus. Parts of the scene falling within the available depth of field become less and less sharp the farther they are from the plane of critical focus. Eventually they become so out of focus they no longer appear sharp at all.

The nearest and farthest points that are acceptably sharp mark the planes of near and far focus. These limits are usually not visible as exactly defined boundaries. Nor can you usually find the plane of critical focus by looking at a picture. Instead, sharp areas imperceptibly merge into unsharp ones. Normally depth of field is not evenly divided by the plane of critical focus. There is almost always more depth of field beyond the plane of critical focus than in front of it. The only exception is when you get very close to a subject, as you might in close-up photography, and the depth of field becomes more evenly divided.

The near and far limits of depth of field are shown here as two planes (B and C), parallel to the plane of critical focus (Av).

Often it doesn’t matter so much exactly what you are focused on. What does matter is whether or not the parts of the scene you want to be sharp fall within the available depth of field. When you want a large part of the scene to be sharp, you increase the depth of field. When you want less of the scene sharp you decrease it. In some scenes, you can increase or decrease the depth of field simply by shifting the point on which you are focused or by changing the aperture setting but you have three factors to work with.
### Effect On Depth of Field

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<thead>
<tr>
<th>Effect On Depth of Field</th>
<th>Deeper DOF</th>
<th>Shallower DOF</th>
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<tr>
<td><strong>Aperture Size</strong></td>
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<td><strong>Camera to Subject Distance</strong></td>
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<td><strong>Focal Length of Lens</strong></td>
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Depth of field is increased or decreased as you change apertures, distances and focal lengths.

**Aperture size.** The smaller the aperture, the greater the depth of field. The larger the aperture, the shallower the depth of field.

**Camera-to-subject distance.** As you move farther from the subject you are focused on, you increase depth of field. As you move closer, you decrease it.

**Lens focal length.** Using a wide-angle lens or zooming out increases depth of field. Using a long lens or zooming in decreases it.

Each of these three factors affects depth of field by itself, but even more so in combination. You can get the shallowest depth of field with a lens zoomed in on a nearby subject using a large aperture. You get the greatest depth of field when you are far from a subject, with the lens zoomed to a wide angle, and using a small aperture.

SLRs normally have their aperture open to its widest possible setting so you have a bright viewfinder as you compose an image. When you press the shutter button all the way down, the aperture then changes to the one used to capture the picture. To check depth-of-field before taking a picture, in all shooting modes other than Scene Intelligent Auto, press the depth of field button. Doing so closes the lens aperture down to the f/stop that will be used to capture the picture so the viewfinder gives you an idea of what’s sharp and what isn’t. However, when using small apertures, the viewfinder image can be very dark. When the maximum aperture is selected, as it often is in dim light, you’ll see no change at all. If you turn on Live View and press the depth of field the effect is more dramatic. Not only that, but in Live View you can magnify any part of the scene to check focus with great accuracy.

Here the greatest possible depth of field was used to keep everything sharp from the fighter’s needle nose to the background.
Chapter 3 Setting the Shutter Speed and Aperture

Topic 3-13. Aperture—Understanding Depth of Field

The aperture is normally wide open for composing an image (left) and stops down when you take a picture (middle) and then reopens (right) after the picture is taken.

To check depth-of-field press the depth-of-field preview button on the front of the camera.

Since the aperture has a major influence on depth of field there is a way you can automatically ensure you have the maximum amount in a given situation:

- To be sure you are using the largest possible aperture for the shallowest depth of field, use shutter-priority (Tv) mode and select the fastest shutter speed you need for sharpness. The camera will then automatically select the largest possible aperture for that situation.
- To be sure you are using the smallest possible aperture for the greatest depth of field, use shutter-priority (Tv) mode. Select the slowest shutter speed you need to freeze action or avoid camera blur and the camera then automatically selects the smallest possible aperture for that situation.

Tips

- To control depth of field, switch to Av (aperture-priority) mode and select a small aperture for great depth of field, or a large aperture for shallow depth of field.
- To get the maximum depth of field it helps if you understand the hyperfocal distance discussed in Topic 4–X.
- Here are some things you can do to increase depth of field:

  **INCREASING DEPTH OF FIELD**
  - Photograph in bright sun so the aperture closes down.
  - Zoom the lens out to a wider angle of view or move farther away from the subject.
  - Switch to aperture-priority (Av) mode and select a small aperture such as f/11.

- Sometimes it’s impossible to get as much depth of field as you need. One way to do so is to take a series of photos focused on different parts of the scene and then blending them into a single sharp image. This technology is discussed in the topic on focus stacking images in Topic 4–X.
- When comparing cameras with small and large sensors, if they both have the same field of view, the camera with the small sensor has more depth of field. That’s why it’s harder to get shallow depth of field or throw the background out of focus with a small-sensored point and shoot camera.

Resources to Explore

1. The Aperture and Depth of Field illustrates how as the aperture gets larger, the depth of field gets shallower and objects in the foreground and background become softer. Here the camera is focused on the gray building, second in on the right, so that’s where the plane of critical focus is. As the aperture is opened one stop at a time, the depth of field in front and behind that plane gets shallower and shallower. [www.photocourse.com/itext/DOF](http://www.photocourse.com/itext/DOF).

2. Click the link to check out depth of field and hyperfocal distance calculators at [www.dofmaster.com](http://www.dofmaster.com).

3. If you have a smartphone, see if your app store has a depth of field calculator. If there is a free one give it a try.

4. A special kind of camera, called a light field camera, allows you to focus
pictures after they’re captured, shift your perspective of the scene, and switch between 2D and 3D views. Click the link to learn more at www.lytro.com.

**Seeing for Yourself**

1. Set your camera to aperture-priority (Av) shooting mode, focus on a nearby subject with a distant background and hold down the depth of field preview button. Turn the Main dial to scroll through one aperture after another as you watch in the viewfinder. Notice how at small apertures it’s darker with greater depth of field and at large apertures it’s lighter with less depth of field. Now do the same with Live View on.

2. Find a landscape that extends from near to far such as a receding picket fence or a street lined with buildings, trees or even parking meters. Select a nearby point in the scene on which to focus. In aperture-priority (Av) shooting mode take pairs of photos as described below and then compare the depth of field in each pair:
   - To see the effect of the aperture select the smallest and then largest possible apertures.
   - To see the effect of camera-subject distance on depth of field photograph from very close then much farther away without changing the aperture.
   - To see the effect of focal length on depth of field shoot with your lens zoomed all the way out and then from all the way in.

3. Find an outdoor scene with large objects in the fore, middle and background. Focus on the middle object and by combining the techniques used in 2 above see if you can make both the foreground and background objects sharp and then soft.

4. Lay a yardstick or an open newspaper on the floor in a bright room and get as close as the camera will focus. With the camera at a 45° angle select the smallest and then largest possible apertures as you take pictures at each setting. Compare them to see the change in depth of field and its effect on what’s sharp and what isn’t. Explore the effects of changing focal lengths and camera-subject distance.

5. With your camera set to a large aperture stand back from a mirror, focus on the frame and take a picture. The frame should be sharper than your image because the depth of field needs to be deep enough to keep everything acceptably sharp from the mirror back out to you. Repeat the process but use a much smaller aperture for greater depth of field.
The Pyramid and Domes in Pyramid Lake, western Nevada. A line of dome-shaped tufa rocks culminating in a large pyramid-shaped tufa rock in Pyramid Lake. Timothy O’Sullivan, in 1867, had to get enough depth of field to keep them all sharp. Courtesy of Wikimedia Commons.

A small aperture keeps everything sharp from near to far in this scene from Gettysburg.

Depth of field is great enough to include both the foreground and background.
When photographing a reflection depth of field must be deep enough to sharply capture whatever is being reflected. In this image the depth of field is great enough to capture both the rock in the pond and the sky reflected in the pond’s surface.

A path curves toward a monument at the Antietam battlefield with all parts of the scene sharp.

Here building are reflected and distorted by the windows in a car.

Here a small aperture on a sunny day gives enough depth of field to capture everything in the image sharply.

Depth of field is a result of different parts of a scene at different distances coming into sharp focus at different points inside the camera. Here is how it works.

- Points in the scene that fall on the plane of critical focus (see Topic 4–2) are projected as points onto the sensor.
- The light forming these points is cone shaped so any point in the scene in front of or behind the plane of critical focus is projected onto the sensor as a circle, not a point. Called *circles of confusion*, these circles increase in size the farther they are from the plane of critical focus. The places where they expand enough to be seen as circles and not points defines the planes of near and far focus, between which lies the available depth of field. The acceptable circle of confusion is often defined as the largest spot on the image that will still be perceived by the human eye as a point. What’s acceptable is affected by one’s vision, distance from the image, its enlargement and the lighting.

The term “bokeh” (pronounced “bo-K”) refers to the way a lens displays points of light that fall in front of or behind the available depth of field. These occur in all out-of-focus areas but are most obvious when they are small highlights such as specular reflections and light sources. They may take the shape of polygons when the light passes through an aperture with a polygonal shape. To capture them you use the same procedures you use for shallow depth of field discussed in Topic 4–X. To have something in the foreground sharp, manually focus on it from close-up with lights in the scene at some distance behind them. Use a large aperture and long focal length lens and as you adjust focus using Live View you can see the highlights go out of focus and become larger or smaller.

If a point in the scene falls on the plane of critical focus (the focus point) it falls on the image sensor as a point—basically the point of a cone. If a point in the scene is in front of or behind the plane of critical focus it falls on the image sensor as a circle—basically a cross-section of a cone. The farther the point lies in front of or behind the plane of critical focus, the larger the circle becomes.

Depth of field is affected by aperture settings because they determine the width of the cone of light entering the camera. A large aperture has a wide cone and a small aperture a narrow one. At any point inside the camera the cross sections of these two differently sized cones of light are larger and smaller. When the...
cross section is the same size as the camera’s acceptable circle of confusion it defines the planes of near and far focus.

Inside Camera

Points in Scene

Small aperture - deep depth of field

Large aperture - shallow depth of field

Areas that fall in front of or behind the planes on near and far focus.

- Circles of confusion are physical properties of optics so there is nothing you can do as a photographer except select smaller apertures to make them smaller and larger apertures to make them bigger.
- The term bokeh comes from the Japanese word for blur or haze.

**Resources to Explore**

1. Search the internet for information on the phrase “circles of confusion”.
2. Search the internet for images that illustrate bokeh then search for the phrase “capturing bokeh” for tips on how you capture this effect.
3. To find what the circle of confusion is for your camera see if it is listed on the DOFMaster Web site at [www.dofmaster.com/digital_coc.html](http://www.dofmaster.com/digital_coc.html).

**Tips**

- Although the smallest aperture gives the greatest depth of field, the sharpest aperture is usually one or two stops larger because the smallest apertures are frequently affected by diffraction patterns.
- The term “defocus” is sometimes used instead of “out of focus” to describe the areas that fall in front of or behind the planes on near and far focus.

**Seeing for yourself**

1. If you have a small flashlight or a flashlight app for your smartphone turn it on in a dim or dark room. Point it at a wall and walk closer to it until the beam is as small as it gets. The shrinking circle of light you see on the wall is the cross section of the cone-shaped beam of light projected by the flashlight.
2. If you have ever used a magnifying glass to start a fire you may remember...
you had to move it forward and back until you found the smallest point of light—the focus point. As you did so, the circle of light increased in size the farther you were from the in-focus point. These circles are like circles of confusion—cross sections of the cone of light used to form images.

3. Try capturing images that show the effects of bokeh. For example, frame any small lights and using a large aperture, manually focus to turn the sharp lights into colored circles. One simple way to see this effect is to cover a cool burning desk lamp with tin foil and prick holes in it with a needle or the point of a freshly sharpened pencil. (Don’t do this with a hot burning bulb since it can cause intense heat in the lamp.) Turn the light on and photograph the small pin pricks of light as described above. Be sure to turn off the lamp when done.

4. Try capturing images with bokeh behind a foreground subject. To do so manually focus on the subject from relatively close-up in a setting where there are points of light some distance behind them. Use a long focal length lens and your largest aperture.

Shallow depth of field softens the background.
Topic 3–15. Aperture—Shallow Depth of Field

Shallow depth of field, sometimes called selective focus or defocusing, is a great way to isolate a subject from a distracting foreground or background. When everything in a picture is equally sharp, the viewer gives equal attention to all parts of the scene. But if some parts of an image are sharp and others are not, the viewer’s eye is drawn to the sharpest part. You can selectively focus the camera and your viewer’s attention on the most important part of the scene by limiting depth of field so it is sharp while the foreground and background are less so.

Here attention is drawn to the sharp monarch butterfly caterpillar. The boy’s face is soft and less distracting, but sharp enough that you can see the expression.

Here only the bubble gum blower is in sharp focus while figures in the foreground and background aren’t.
Here are some things you can try to decrease depth of field:

**DECREASING DEPTH OF FIELD**
- Photograph in dim light or use a neutral density filter to open up the aperture.
- Move closer to the main subject or use a longer focal length lens.
- Use aperture-priority (Av) mode and select a large aperture such as f/4.

**Tips**
- Selective focus has its most dramatic effect when the main subject is near the camera and the background is a great distance off.

**Resources to Explore**

1. **Selective Focus** demonstrates how you can shift the plane of critical focus to any part of the scene. When a large aperture is used to reduce depth of field, only the areas immediately around the plane are sharp while those farther away are soft. Here the plane shifts between the flowers in the foreground and the building in the background. [www.photocourse.com/itext/selectfocus](http://www.photocourse.com/itext/selectfocus).

**Seeing for Yourself**

1. Arrange three cans or other objects on the diagonal so they are all within the image frame but at different distances from the camera position (maybe a foot or so apart). Using aperture-priority (Av) shooting mode, select the largest aperture your lens offers. Focus on the middle object and take a photo to see if the near and far objects are soft while the center one is sharp. Experiment with different camera-subject distances and lens focal lengths.

2. Outdoors find a scene with large objects in the fore, middle, and background. Repeat 1 above to see if you get the same results. Try varying your distance to the subject and focal length of your lens.

3. Lay a ruler or an open newspaper on the floor or table and get as close as the camera will focus. Using a wide aperture and shooting at a 45° angle, focus on a line in the middle of the page or ruler and take the picture. Repeat the same step but focus on a different line. Are the lines you focused on the sharpest in the images? Are the lines in front and behind that point soft and out of focus?

Photograph the same setup with the following two combinations:

- Move the camera back, zoom out and select the smallest aperture to increase depth of field.
- Move the camera closer, zoom in and select the largest aperture to decrease depth of field.

4. Find a flower or other small object with a distant background—perhaps 10 or more feet away. Set the camera to its largest possible aperture and zoom the lens all the way out to its shortest focal length. Get as close to the object as your camera’s minimum focus distance allows and focus on it. Take a picture to see if your camera throws the background out of focus.

The car is so sharp compared to the background in almost looks 3D.
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This portrait of Walt Whitman taken by Alexander Gardner in 1863 uses selective focus to draw attention to the center of Whitman’s face. Whitman referred to it as “the best picture of all.” Courtesy of the Library of Congress.

This young man was photographed near Cincinnati, Ohio by John Vachon while on assignment for the Farm Security Administration in 1942 or 1943. He used shallow depth of field to soften the background. Courtesy Wikimedia Commons.

Shallow depth of field highlights a pair of sharply focused mating monarch butterflies.
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Topic 3-15. Aperture—Shallow Depth of Field

Shallow depth of field softens everything behind the man with the flag at the funeral for a serviceman killed in Afghanistan.

Rev. Martin Luther King, Jr. with President Lyndon Johnson in the background. Selective focus was used to make Dr. King stand out sharply against a soft background. Photo by Yoichi Okamoto, Washington, DC, March 18, 1966. Courtesy of National Archives.

Most serious photo-editing programs such as Photoshop, Lightroom and Photoshop Elements let you use a histogram as a guide when editing your images. However, since most image corrections can be diagnosed by looking at a histogram, it helps to look at it while still in a position to reshoot the image. It’s for this reason that an image’s histogram can be displayed on the camera’s monitor. As you’ve seen, each pixel in an image can be set to any of 256 levels of brightness from pure black (0) to pure white (255) and a histogram graphs the number of pixels at each level of brightness. It’s called “active” because it reflects the current scene and not a captured image.

Displaying Histograms

You can display a histogram after taking a photo and as you are taking one. In the first case you display a histogram in playback mode or during auto review. In the later case you display one, called an active histogram, in Live View.

To see a histogram all you have to do is press the INFO button until one is displayed. There are two kinds of histograms:

- The default Brightness histogram combines the red, green and blue channels in an image to show you its overall brightness.
- The optional RGB histogram displays the levels of brightness of each color that makes up an image—red, green and blue. This allows you to see if you are under- or overexposing a specific color.

When you display a histogram in playback and auto review it is accompanied by a thumbnail image. You can have any overexposed and burned out highlights without details (“clipped” areas) blink using the Playback 3 menu’s Highlight alert setting.

Displaying Histograms

- To turn histograms on or off in auto review, playback or Live View press INFO. (In playback mode the display must be set to single image view.)
- To change between the brightness and RBG histograms display the Playback 2 menu tab and select the Histogram display setting.
- To have highlights with burned out values blink in the small thumbnail set the Playback 3 menu tab’s Highlight alert setting to Enable (the default is Disable).
Evaluating Histograms

The horizontal axis of a histogram represents the range of brightness from 0 (shadows) on the left to 255 (highlights) on the right. Think of it as a line with 256 spaces on which to stack pixels in the image that have the same brightness. Since these are the only values that can be captured by the camera, the horizontal line also represents the camera’s maximum potential tonal range or contrast.

The vertical axis represents the number of pixels that fall on each of the 256 available brightness values. The higher the line coming up from the horizontal axis, the more pixels there are at that level of brightness.

To read the histogram, you look at the distribution of pixels. Many, but not all, photos look best when there are some pixels at every position because these images are using the entire tonal range. Here are some things to look for.

- **Evaluating Histograms**
  - If the histogram shows most pixels toward the left (darker) side of the graph, use exposure compensation to add exposure.
  - If the histogram shows most pixels toward the right (lighter) side of the graph, use exposure compensation to reduce exposure.

- In many images, pixels are grouped together and occupy only a part of the available tonal range. These images lack contrast because the difference between the brightest and darkest areas isn’t as great as it could be. However, this can be fixed in a photo-editing program using controls that spread the pixels so they cover the entire available tonal range. These controls allow you to adjust the shadow, midtone, and highlight areas independently without affecting the other areas of the image. This lets you lighten or darken selected areas of your images without losing detail in other areas. The only pixels that can’t be improved are those that have been “clipped” to pure white or black.
  - In a color RGB histogram, too many pixels to the left indicate that colors may be weak. If there are too many to the right, the colors may be too saturated and lack details.

Clipped Pixels

When a histogram shows pixels at the extreme ends of the range, in the 0 and 255 positions, it means details in those tones are being lost or “clipped” in your image. These extremes should be reserved for specular highlights (reflections) and small dark black shadows like those at the bottom of a well. When large areas lack detail an image usually suffers.

To avoid clipping and improve the placement of tones, you use exposure compensation.
  - Increasing exposure shifts pixels to the highlight, or right end of the histogram.
  - Decreasing exposure shifts pixels to the shadow, or left end of the histogram.

Unless you are deliberately trying to get pure whites or pure blacks, you should shift the pixels if any are being clipped. This then gives you a chance to correct the image in your photo-editing program.
Here you can tell from the histogram that some of the highlight pixels are pure white and hence clipped. There is nothing you can do later to display details in the area of these pixels.

If you reshoot the scene at a different exposure you can first shift the pixels to the left and avoid the clipping.

The histogram on the left shows that the image is overexposed and pixels at the far right end (the highlights) are being clipped. Using exposure compensation at the time the photo was taken shifted the histogram to the left (right). With this adjustment no details are lost in the shadows or highlights.

This series of photos was taken one stop apart using exposure compensation. As the exposure increases, pixels on the histogram shift right. You can tell from the way the fan blades blur that the shutter speed was changed to change the exposure. In the image where it was faster, the image is darker and the blades are frozen. As slower speeds were used to increase the exposure, the images get lighter and the blades more blurred.

### Sample Histograms

The way a histogram looks depends on the scene you’re shooting and how you expose it. There’s no such thing as a good or bad histogram, other than those showing clipping and even those aren’t always bad. Whether a particular histogram is good or bad depends on what you are trying to accomplish. If fact, you may prefer to trust your visual reaction to the image more than the very numeric image data provided by a histogram. However, even if you never use a histogram, you can learn about digital photography by understanding what a histogram can reveal. Following are some histograms from good images along with a brief summary of what each histogram reveals.
In this well exposed portrait there is a fairly even distribution of values in both the shadow and highlight areas. There are no pure blacks in the image as shown by the gap at the far left end of the scale.

This brown moth on a gray card has most of its values in the midrange. That’s why there are a number of high vertical lines grouped in the middle of the horizontal axis.

This high-key fog scene has most of its values toward the highlight end of the scale. There are no really dark values in the image. The image uses only a little more than half the camera’s tonal range. The distinct vertical line to the left of middle gray shows how many pixels there are in the uniformly gray frame border added in Photoshop.

This low-key scene has the majority of its values in the shadow area with another large grouping around middle gray. There are wide levels of brightness that have only a few pixels.

A color histogram shows the brightness of each of the three colors—red, green and blue. This one is from Photoshop.

**Tips**

- If Highlight alert on the Playback 2 menu tab is enabled, and clipped areas in the thumbnail blink, you can shift the clipped areas using minus (-) exposure compensation.
- When shooting JPEGs if highlights are being clipped in wedding dresses, clouds, snow and other bright subjects, you can display the Shooting 3 menu tab and enable Highlight tone priority to preserves details in these bright areas of the image and prevent them from being clipped.
- A histogram can’t be displayed when an image is zoomed or displayed in index mode.

**Resources to Explore**

1. **Highlights Warnings** may be displayed when you review your images. Areas of the image that are pure white, without any detail, blink or are outlined in color. Skies are often pure white but the only areas on an image that should al-
ways be like this are spectral highlights such as reflections. [www.photocourse.com/itext/highlight](http://www.photocourse.com/itext/highlight).

2. **Understanding Histograms** illustrates how as the exposure increases the photo gets lighter and the pixels in the histogram shift to the right. [www.photocourse.com/itext/histogram](http://www.photocourse.com/itext/histogram).

3. Search the internet for the term “live histogram” to see what information you can find on this feature.

4. Although you usually want to preserve highlight and shadow detail there are times when you may not want to. Search the Internet for Brett Weston’s photo “Broken Window” to see how a pure black area can create a mysterious void in an image.

### Seeing for Yourself

1. Display Target 9 *White Card* in Appendix A full-screen. Set the camera to Program AE (P) shooting, spot metering, and Live View modes, then display the active histogram. Point the spot metering circle at the white card as you change the exposure compensation from 0 to +1, +2, -1 and -2 as you watch the histogram move to the right and then left. Can you adjust it to get or avoid clipping in the highlights? When it moves to the left what does it indicate? To the right?

2. Display Target 5 *Ten Step Grayscale* in Appendix A full-screen. Set the camera to Program AE (P) shooting, spot metering and Live View modes and display the active histogram. Point the spot metering circle at each section of the scale and notice how the histogram and settings change as you point at lighter or darker tones. Switch to evaluative metering and frame all 10 steps to see their spikes on the histogram.

3. Display Target 6 *Color Histogram* in Appendix A full-screen. Set the camera to Program AE (P), evaluative metering and Live View, then display the live RGB histogram. Frame all three colors and notice on the RGB histogram how narrow the tonal range is for each solid color. Now look at the brightness histogram and note how it differs.

4. Display Targets 7 *Tonal Range—Narrow* and 8 *Tonal Range—Wide* in Appendix A full-screen. Set the camera to Program AE (P), evaluative metering and Live View, then display the live brightness histogram. Display the histogram for each of the images and note the following:

   - The tonal range of one of the images is much narrower and occupies less of the horizontal axis than the range of the other.
   - In one of the images there is clipping in the highlights because the scene contain spectral highlights which are pure white with no detail.

5. With the camera in Program AE (P), AI Servo AF and the Live View histogram displayed do as follows:

   - Use program shift to select various pairs of settings. Notice what, if anything, happens to the histogram and image.
   - Use exposure compensation to increase and decrease the exposure. Notice what, if anything now happens to the histogram and image.

6. Scroll through your images in playback mode with the camera’s highlight alert on and see if any of your images have burned out highlights. Also look at the histogram to see the clipped pixels.
This image of an Oklahoma boy during a dust storm is by Arthur Rothstein and has a tonal range narrow enough to be fully recorded.
All exposure systems, including the one built into your camera, operate on the same general principles. A meter measures the light that reflects from the subject and enters through the lens (TTL). The system then uses this measurement to calculate and set the shutter speed and aperture.

Your camera’s meter measures light reflecting from the part of the scene shown in the viewfinder. The coverage of the meter (the part of the scene that it includes in its reading) changes just as your view of the scene changes when you change your distance to the scene or zoom the lens. Suppose you move close or zoom in and see in the viewfinder only a detail in the scene, one that is darker or lighter than other objects nearby. The suggested aperture and shutter speed settings will be different for the detail than for the overall scene.

Your exposure meter doesn’t “see” a scene the same way you see it. Its view is much like yours would be if you were looking through a pane of frosted glass.

The exposure system in your camera can’t think. It does exactly what it’s designed to do and that is only one thing. Regardless of the scene, its subject matter, color, brightness, or composition, the meter measures only average brightness, or how light or dark the scene is. Imagine a scene with only white, gray and black paint in it. Now imagine that paint all stirred together to form an average gray. The camera’s automatic exposure system does this averaging then calculates and sets the aperture and the shutter speed to render this average level of brightness as “middle gray” in the photograph. Most of the time this works very well because most scenes have an overall brightness that averages out to middle gray. But some scenes are lighter or darker on average and that’s when autoexposure will lead you astray. Let’s see why.

Most scenes contain a continuous spectrum of tones, ranging from pure black at one end to pure white at the other—the brightness. When shooting JPEGs you can capture 256 tones in this scale ($2^8$). The tone in the middle of this range is middle gray and reflects exactly 18% of the light falling on it.

When you photograph a subject, your camera’s autoexposure system sets the exposure so the average brightness in the image is middle gray regardless of the scene’s actual brightness. As a result, when you photograph a scene with an average brightness lighter or darker than middle gray, it will be too dark or light in the image. For example, if you photograph a white card, a gray card, and a black card, and each completely fills the viewfinder when the exposure is calculated, each of the cards will be middle gray in the captured image.
Because of the way your exposure system works, if you photograph a white card, a gray card, and a black card (top), the exposure system sets the camera to capture each as middle gray (bottom).

To make scenes that are lighter or darker than middle gray appear in an image the way they appear in real life, you have to use exposure compensation or some other form of exposure control discussed later in this chapter to lighten or darken the picture.

When you fill the viewfinder with a gray card and press the shutter button halfway down, your camera will indicate the best exposure regardless of how light or dark the scene is.

Tips

- If an exposure setting will make an image too over- or underexposed in Live View, the image on the monitor will look too light or dark. If this happens select another setting or use exposure compensation.
- Professionals will often put a gray card in the scene for a final test shot. They then remove it for the actual photos but the one they saved with the gray card in the scene can be used later when adjusting exposure and white balance in a photo-editing program.

Before meters were built into cameras Ansel Adams and just about everyone else carried a Weston meter to measure the light and calculate the best exposure manually. Courtesy of www.myphotoweb.com.

Resources to Explore

1. **How Your Meter Sees** makes the point that the exposure meter in your camera doesn’t see the same detail you see. It sees only averages, as if you were looking at the scene through a sheet of frosted glass. [www.photocourse.com/itext/frostedglass](http://www.photocourse.com/itext/frostedglass).

2. Search the Internet for the terms “middle gray and grayscale” to learn about these tones.

Seeing for Yourself

1. Display Targets 9 White Card, 10 Gray Card and 11 Black Card in Appendix A in turn so each fills the monitor. Set your camera to Program AE (P) shooting mode, Live View, evaluative metering and an ISO of 100. Do as follows as you frame each target:
   - Write down the suggested aperture and shutter speed.
   - Take a photo of each.
   - Notice how the brightness of the image on the camera’s monitor changes as you move from one tone to another.

When finished look at all three images at the same time in playback’s index mode. Can you tell which is which? How? Does each perfectly match the subject?
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2. Display Target 12 Stamp Against Black in Appendix A full-screen. Set your camera to 100 ISO, Program AE (P), and Live View then do as follows:

- Set your camera to evaluative metering, frame the target on the monitor, then write down the exposure and take a picture.

- Switch to spot metering and meter first the background and then just the stamp as you take pictures and write down the exposure settings and take a picture while metering the stamp.

How do the settings and pictures compare?

3. Open an image in Photoshop, and use the Filter > Blur > Average setting to convert it to its average grayscale tone. Compare this to an image of middle gray to see if the scene’s average brightness is lighter or darker than middle gray. (Using Photoshop you can also select a small area of the image and set the color picker so R, G and B are all 127 and then use the paint can to fill the selected area with this middle gray so you can compare it to the image.)

A middle gray scene showing grain elevators in Amarillo, Texas along the route of the Atchison, Topeka and Santa-Fe Railroad. Taken by Jack Delano in 1943. Courtesy of the Library of Congress.

Reflections of elevators in the still water is approximately a middle gray scene.
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### Topic 3–18. Exposure—Metering Methods

All parts of a scene are usually not equally important when determining the best exposure to use. In a landscape, for instance, the exposure of the foreground is usually more important than the exposure of the sky. For this reason, the D70 Mark II offers various metering methods.

- **Evaluative metering** divides the scene as seen through the viewfinder into 35 zones, each of which is linked to the AF points. Each of the 35 zones is the same size and they are laid out in a 7 x 5 matrix. When using autofocus, the metering system gives special emphasis to the subject you’re focused on at the active AF point. This mode is the default in all shooting modes because it’s ideal for general shooting conditions and backlit scenes. This is the only mode available in Scene Intelligent Auto. When used with manual focus, metering is based on the center AF point.

**Changing the Metering Mode**

With the Mode Dial set to any mode other than Scene Intelligent Auto, press the Metering button on top of the camera and then turn the Main Dial to cycle from evaluative (the default) through center-weighted, spot partial, and back to evaluative metering.

This mode differs from the three that follow in one other respect. When using evaluative metering with One-Shot AF (the default), pressing the shutter button halfway down locks both exposure and focus. When using AI Servo AF, neither is locked and both are set when you take the picture. Any other combination of metering and focus modes locks just focus.

- **Partial metering** meters the part of the scene falling within the circle of AF points in the center of the viewfinder. This zone covers only 9% of viewfinder area so you can meter just a specific part of the scene instead of relying on an overall reading. This mode is ideal when photographing a subject against a very dark or very light background. You can also meter any part of the scene and use AE Lock to use that reading for the overall photo.

- **Spot metering** meters 3.8% of the viewfinder area—the area within the viewfinder’s spot metering circle. This mode is similar to partial metering but is better when you want to base your exposure on an even smaller part of the scene.

- **Center-weighted average metering** meters the entire scene but assigns the most importance to the center of the frame where the most important subjects are usually located.

Metering can cause problems if the camera isn’t metering the main subject or when the main subject is very dark or light. For instance, a dark object located off center against a very light background may not be exposed properly if it is not located in the area the meter is emphasizing. These occasions are uncommon, but when they occur you can ensure accurate exposures using exposure compensation, AE Lock and autoexposure bracketing.

**Tips**

- Evaluative metering is designed to ignore bright hot spots, such as reflections, that would affect the exposure. How many zones does it meter?

- Once you change the metering mode it usually remains changed until you change it back. Forgetting to do so can lead to exposure errors on subsequent shots.
Resources to Explore

1. Meters built into a camera measure the light reflecting off a scene and entering the camera through the lens (TTL). Another type of meter is the incidence meter. Because these meters read the light falling on the subject, rather than the light being reflected, they aren’t fooled by the subject’s tonality, color, and contrast. Unfortunately to use this metering technique you have to purchase and carry a separate meter and meter from the subject’s position not from the camera’s. To learn more, search the internet for “incidence metering”.

2. If you do a lot of flash photography you may want a meter that can meter the light from multiple flash units. To learn more, search the internet for “flash meters”.

Seeing for Yourself

1. Display Target 13 Black and White in Appendix A full-screen. Set your camera to Program AE (P) shooting mode, spot metering, ISO 100 and Live View. Move the spot metering area slowly from a dark area to a light one to see if you can tell how small an area it’s metering. The exposure readouts, and the image on the monitor, should change as soon as it starts crossing the dividing line between dark and light.

2. Display Target 14 Bulls eye Grayscale in Appendix A full-screen. Set your camera to Program AE (P) shooting mode, spot metering, ISO 100 and Live View.

   • Frame the tones as you switch from evaluative, to center, to spot metering, writing down the suggested exposures for each.

   • In each metering mode, try pointing at different tones to see if the camera responds by changing the exposure. (You may have to press the shutter button halfway down each time to see any changes.)
As discussed earlier, the camera’s autoexposure system meters the light reflecting from a scene and averages it out. It then sets the aperture and shutter speed to render this average as middle gray in the image. This gives you a perfect exposure if the scene also has an average of middle gray and most scenes are close. Some areas of the scene may reflect 90% of the light and other parts may reflect 5%, but overall the average amount of light reflecting from the scene is 18%, the amount reflected by a middle gray subject. Ansel Adams in his book *The Negative* lists typical middle gray subjects as a clear north sky, dark skin, average weathered wood, and the average brightness of rocks in sun and shadow.

Portraits in indirect light generally have the tones needed to get a good image without additional exposure control.

**Tips**

- The image displayed on the camera’s monitor gives you a good idea if the scene is middle gray. If it is, the image will look natural, just like the scene. Check small light or dark areas that may be under or over exposed because they fall outside of the current tonal range. If any of these areas are important you want them to have detail. To check them in Live View zoom the image, and in playback mode enlarge and scroll around them. To make the image lighter or darker, use exposure compensation.

- For the best chance of getting a perfect exposure shoot RAW. Images in this format can be adjusted plus or minus at least one or two stops in a photo-editing program without seriously affecting their quality.

- The best way to check exposure is by studying the histogram.
Resources to Explore

1. You can use evaluative metering and the histogram to determine if a scene has an average of middle gray. Most of the pixels in the histogram should be grouped around middle gray and not be noticeably shifted left or right.

2. Ansel Adams used the Zone System to determine exposure times. In that system middle gray falls in Zone V (zone five) so search the Internet for “Zone V” to see what examples you can find of that zone. This is also discussed in this book in Topic 3-25.

Seeing for Yourself

1. Look through your photos to see if any have dark or light areas that are so under or over exposed they lack details.

2. Meter a gray card while viewing it’s histogram and remember where gray falls on the histogram’s horizontal axis. You can also photograph the card and keep the image on your memory card for future reference. To recall where middle gray falls just display the image in playback mode and check the histogram again.

3. If your camera has a live histogram in shooting mode, use spot metering to see if you can find any middle gray objects in your vicinity. As you find them make a list or take their picture.

This scene is very close to middle gray.
When you photograph scenes with an average brightness lighter or darker than middle gray they will come out darker or lighter in their pictures because the exposure system adjusts the exposure to make them middle gray. To do so it increases the exposure to lighten dark scenes and decreases it to darken light ones. It’s for this reason that you can’t always trust the exposure system to give you the results you want.

Let’s take a look at some of the most common situations where your automatic exposure system will cause exposure problems. It’s in these situations that you’ll need to use exposure compensation to override the suggested exposure settings.

### Scenes Lighter than Middle Gray

Scenes lighter than middle gray, such as beach scenes with bright sand or snow covered landscapes, reflect more than 18% of the light falling on them. The autoexposure system doesn’t know the scene should look bright so it calculates an exposure that produces an image that is too dark. To lighten the image so it matches the original scene, you must override the camera’s automatic exposure system to add exposure.
Scenes Darker than Middle Gray

Scenes that are darker than middle gray, such as deep shadows, dark foliage, and black cloth, reflect less than 18% of the light falling on them. If you photograph such scenes using automatic exposure, they will be shifted to an average middle gray and appear too light. To capture images of such scenes with realistic tones you have to override the autoexposure system to decrease the exposure to make the picture as dark as the scene.

The black cat is between one and two stops darker than middle gray. To darken the scene so it’s not middle gray, exposure must be decreased by one (-1) or two (-2) stops.

Subject Against Very Light Background/Backlit

Subjects against a very light background, or between you and the light source—called backlit—can be exposed incorrectly, particularly if the subject occupies a relatively small part of the scene. This happens because the brightness of the background is so predominant that the automatic exposure system reduces the exposure to render its brightness as a middle gray. The result is an underexposed and too-dark main subject. Evaluative metering is designed to detect these scenes and fire the flash to fill the shadows—a form of automatic exposure compensation. Any changes you make to exposure compensation will have the greatest effect on the part of the scene not illuminated by the flash—usually the background.

A lighthouse at dawn is silhouetted against the lighter sky.

Here the men are backlit and the scene was exposed for the brighter background, underexposing the men in the foreground, leaving them silhouetted. To show detail in the people, exposure would have had to have been increased two stops (+2).
Subject Against Very Dark Background

When a small bright subject appears against a large dark background, your autoexposure system increases the exposure to produce a middle gray tone. The result is an overexposed and too light main subject.

Scenes with High Contrast

Many scenes, especially those with brightly lit highlights and deep shadows, have a brightness range that cannot be completely recorded by an image sensor. When confronted with such scenes, you have to decide whether the highlight or shadow area is most important, then set the exposure so that area is shown the way you want it in the final picture. In high contrast situations such as these, use spot metering, or move close enough so the most important area fills the viewfinder. Use AE lock from that position to lock in the exposure.

Another way to deal with high contrast is to lighten the shadows by adding fill flash. A portrait, for example, lit from the back or side is often more effective and interesting than one lit from the front. But when the light on the scene is contrasty, too much of the person’s face may be in overly dark shadow. In this case fill flash or a white reflector can fill and lighten the shadows.

Finally, you can use the camera’s HDR setting that takes a series of images at different exposures and then combines one image from the best parts of the others.
The archway was in the shadows and dark, while the cathedral was brightly lit by the sun. Both couldn’t be exposed properly, so the archway was left as a solid black.

This scene has a bright sky and one brightly illuminated fisherman against a dark background. A scene such as this is hard to meter because the key figure—the fisherman—is too small to meter.

**Tips**

- Spot metering gives you more accurate readings for a number of these scenes because it lets you choose a small area on which to base your exposure. When used with exposure compensation and AE Lock you can store the setting while recomposing and shooting the image.

- No matter what the lighting is the RAW file format lets you make better use of a photo-editing program to adjust the tonal range of your photos to open up shadows and recover details in highlights.

**Resources to Explore**

1. Search your camera’s user guide to see if your camera automatically recognizes and adjusts exposure for backlit subjects.

2. Search the Internet for “high contrast photography” to learn more about these kinds of scenes.

**Seeing for Yourself**

1. Locate a scene that is similar to any of those discussed in this section and photograph it in Program AE (P) shooting mode to see what happens to the image if you make no adjustments.

2. Set your camera to Live View and display Target 5 Ten Step Grayscale in Appendix A full-screen. With the camera in Program AE (P) shooting mode and...
spot metering point the camera at each of the strips in the scale while watching the effect it has on the way that strip and others are displayed on the monitor.

A scene in Mexico captured in soft even lighting.

A metal moose in the Adirondack mountains of New York. The light is softened by the morning mist.

A rock cut along the highway around Mt Hood in Oregon.
**Chapter 3 Setting the Shutter Speed and Aperture**

**Topic 3–21. Exposure—How Overriding Auto Works**

Since exposure system expose every scene so it’s middle gray there are times when you need to lighten or darken the image by increasing or decreasing its exposure. Here are some typical settings where you’d make these changes.

- **+2** is used when the light is extremely contrasty and you want to lighten shadows even if doing so burns out the highlights.
- **+1** is best for sidelit or backlit scenes, beach or snow scenes, sunsets and other scenes that include a bright light source, or very light objects, such as a white china on a white tablecloth.
- **0** (the default) is best for scenes that are evenly lit and when important shadow areas are not too much darker than brightly lit areas.
- **-1** is for scenes where the background is much darker than the subject, such as a portrait in front of a very dark wall. This setting is also good for very dark objects, such as black china on a black tablecloth.
- **-2** is for scenes of unusual contrast, as when an extremely dark background occupies a very large part of the image and you want to retain detail in the brighter parts of the scene. For example, when photographing a sunlit flower in front of a dark shadow area.

1. Here are three cards that you photograph with each filling the monitor at the time you take the picture.

2. The camera’s exposure system makes all three cards appear gray in the photographs. Only the middle gray card in the center is exposed correctly.

3. Increasing the exposure for the white card and decreasing it for the black captures them as they really appear. Only the middle gray card in the center doesn’t need the exposure adjusted.

**Tips**

- When adjusting exposure in an automatic shooting mode the camera changes the aperture, shutter speed or both. Which is changed is based on an algorithm that varies from camera to camera.
- The 7D Mark II lets you adjust exposure by up to + or - three stops.
- The number of stops needed to adjust exposure are also discussed in the topic “Placing a Value” later in this chapter.

**Resources to Explore**

1. Exposure can be adjusted in a photo-editing program as well as in the camera. Using the RAW format generally gives you better results when you do this. Search the Internet for “adjusting exposure in lightroom” substituting the name of the photo-editing program you are using in place of “lightroom”.

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*This lighthouse in the fog on Cape Cod would have been too dark if exposure compensation hadn’t been used to lighten it.*
Seeing for Yourself

1. With your camera in Live View set it to spot metering. Point the spot metering circle at different parts of a scene as you watch the aperture and shutter speed readings change along with the image. (You may have to press the shutter button halfway down to see the changes.)

2. Open Target 15 or 16 Picture with Grayscale in appendix A and display it full-screen. Set your camera to Program AE (P) shooting mode, spot metering, ISO 100 and Live View. Point the spot metering circle at a number of the tones at the bottom of the photo. As you do so notice on the camera’s monitor how the brightness of the image and other tones change. (You may have to press the shutter button halfway down to see each.)

The sky behind the truck was so bright exposure had to be set to +1 or detail would have been lost in the shadow areas.

Exposure was increased one stop to lighten this winter scene in New England.
**Chapter 3 Setting the Shutter Speed and Aperture**

### Topic 3–22. Exposure—Compensation

When you want to lighten or darken an image you can use exposure compensation to increase or decrease the exposure recommended by the camera by up to 3 or stops in one-third stop increments. To lighten a picture, you increase the exposure; to darken one, you decrease it. The amount you increase or decrease it is specified in “stops”. For example, to increase the exposure 1 stop, you specify +1 to open the aperture or slow down the shutter speed. It’s as if you were in Manual (M) mode and changed the shutter speed or aperture one stop while leaving the other unchanged. However, in auto mode an algorithm determines which is changed. It’s easy to use exposure compensation because you can preview your changes on the camera’s monitor and reshoot if necessary.

**Using Exposure Compensation**

1. With the Mode Dial set to P, Tv or Av shooting mode, press the shutter button halfway down to activate metering, and then turn the Quick Control Dial to move the marker on the exposure level indicator displayed in the viewfinder and on the LCD panel.
   - To darken the image, move the marker toward the minus (-) end of the scale.
   - To lighten the image, move the marker toward the plus (+) end of the scale.
2. When done, reset exposure compensation to 0 otherwise it will be remembered even when you turn off the camera.

**Tips**

- One shortcut to exposure compensation is to use spot metering and AE lock. Lock exposure on a darker area to make the image lighter. or on a lighter area to make the image darker. Through trial and error you should be able to find a tone in the scene that, when metered, sets the best possible exposure for the entire scene. Use exposure lock or AE lock to retain the exposure settings as you recompose the image and focus on the scene.
- You can set exposure compensation using the Quick Control dial, the Quick Control screen or using the Expo.comp/AEB setting on the Shooting 2 menu.
- In Manual (M) mode, if you set the ISO to any setting other than Auto the exposure level indicator at the bottom of the viewfinder disappears. To judge exposure you must use the vertical indicator on the right side of the viewfinder.
- When you press the shutter button halfway down, the vertical exposure level indicator on the right side of the viewfinder can be used to guide you. It is discussed in detail in Topic 3–7.
- You can use the Exposure level increments setting on the Custom functions 1 menu tab to specify if exposure compensation in one-half or one third stop increments.
- Once you change the exposure compensation setting it stays changed until you change it back. If you don’t return it to 0, all of your photos may be too light or dark.
- In very bright or dark settings, or when you use the flash, your results may not be what you expect.
Autoexposure bracketing is an automated form of exposure compensation.

Another way to look at exposure compensation is discussed in the topic “Placing a Value” that’s based on the Zone System.

Flash compensation can be used to lighten or darken flash exposures.

Manual (M) and Bulb (B) are the only shooting modes that change the exposure when you change the aperture or shutter speed.

Resources to Explore

1. **Exposure Compensation** is shown lightening or darkening a picture by increasing (+) or decreasing (-) the exposure at [www.photocourse.com/itext/expcomp](http://www.photocourse.com/itext/expcomp).

2. Exposure compensation affects the entire image but there is one way to do it selectively. A gradient filter on the front of the lens will block some of the light from the sky so it isn’t burned out when you expose for the foreground. To learn more, search the Internet for “neutral density gradient filters”.

Seeing for Yourself

1. With your camera in Live View use exposure compensation to adjust the exposure as you watch the image on the monitor get darker and lighter. Notice how all of the tones in the image get lighter or darker together.

2. Display a histogram in Live View then change exposure compensation as you watch both the image and histogram on the monitor change. Adjust the exposure +1, +2, -1 and -2 to see how the image and histogram reflect the changes.

3. Display Target 15 or 16 Picture with Grayscale in Appendix A full-screen. Set your camera to Program AE (P) shooting mode, spot metering and Live View. Point the spot metering area at each tone on the grayscale and:
   - Watch the effect that the area you meter has on the overall exposure. Find one tone that when metered adjusts the exposure so the entire scene appears to be properly exposed.
   - Watch the shutter speed, aperture and image brightness change on the monitor. What happens to the overall scene when you point to a dark area? A light area? Is there one tone you can point at that makes all of the other tones on the grayscale visible? Try the same thing in center and evaluative metering modes to see how the results differ.

4. Begin by composing an image of a blank wall with the camera supported, so it doesn’t move and affect the exposure, and set the metering mode to spot:
   - Set the shooting mode to Program AE (P), press the shutter button halfway down and write down the aperture and shutter speed.
   - Adjust the exposure +2, and again press the shutter button halfway down and write down the aperture and shutter speed.
   - Now repeat this process with the camera in aperture-priority (Av) mode and then in shutter-priority (Tv) mode.

Is there a pattern in which setting is being adjusted to increase the exposure?

5. Display Target 17 Highlight Alert in Appendix A full-screen. Use +2 exposure compensation and take a photo of the target. In playback mode display the histogram and highlight alert to see that the bright areas of the image have been clipped. Take another photo using exposure compensation to darken the image enough to capture detail in the highlights, then check the results in playback mode. If necessary, continue until you find an exposure that doesn’t clip the highlights.

6. If you have a smartphone and camera app, compose an image and tap a light area to see if it makes it darker or a dark area to see if it makes it lighter.
During the 1906 San Francisco earthquake, a statue of Louis Agassiz fell from its niche on the front of the Stanford University zoology building. The image would have been slightly underexposed to retain details in the statue’s highlights against the much darker background.

Exposure compensation may have been needed to retain detail in the snow in Herbert Ponting’s photograph of The ‘Terra Nova’ at the ice foot, Cape Evans in 1911. Courtesy of Wikimedia Commons.

Here exposure compensation was used to keep the dark mass of the building and the ocean beyond from being too light.
When the main subject isn’t in the center of the monitor or viewfinder, or you want to base your exposure on a specific part of the scene, you can lock both focus and exposure by pressing the shutter button halfway down. You then continue holding it there as you recompose the image before pressing it the rest of the way to take the picture.

Pressing the shutter button halfway down locks exposure and focus and pressing it all the way down takes the picture.

Instead of locking both focus and exposure, you can use the camera’s AE Lock (AEL) feature that gives you much more control by letting you lock just exposure so you can lock focus separately. Here is how you use it:

Using Autoexposure (AE) Lock

1. With the flash closed, the Mode Dial set to P, Tv or Av shooting mode and metering set to partial or spot, select the AF point you want to use (Topic 4–X) and focus on the part of the scene on which you want to lock exposure.

2. Press the shutter button halfway down to lock exposure and focus, then press the AE/FE Lock button. An asterisk to the left of the shutter speed in the viewfinder indicates that exposure is locked as long as metering is on, or until you release the shutter or AE/FE Lock button.

3. Release the shutter button and recompose the scene. Press the shutter button halfway down to refocus and take your photo. AE lock turns off automatically.

- To cancel AE lock without taking a picture, release the shutter button and wait 4 seconds for the * icon to disappear.
- To keep AE locked for other photos keep the shutter button pressed halfway down, or continue holding down the AE Lock button.

The metering method you are using determines which AF point is used for AE Lock.

- When used with evaluative metering, exposure is based on the automatically or manually selected AF point. When used with center-weighted, partial or spot metering, or when manually focusing, exposure is based on the central AF point.
Exposure lock and AE Lock work best with the camera set to spot metering and a single focus area because these settings give you more control over which area you are locking on to. Once you lock exposure you can recompose the scene, or even move forward or back to then set focus.

When you press the AE/FE Lock button with this icon, exposure is locked and the same AE/FE Lock icon flashes in the viewfinder.

Tips

- AE Lock works best when you use spot or partial metering and use a single AF point to lock on the part of the scene that’s most important for the exposure.

- There is a very subtle difference in the names of these features. Exposure lock is performed by pressing the shutter button halfway down. AE lock (AEL) is done with a separate AE lock button.

- When using the built-in flash or external Speedlight, the AE/FE Lock button acts as a FE Lock (FEL) button.

- When you lock exposure, the vertical exposure level indicator on the right side of the viewfinder continuously displays the AE lock exposure level and the current exposure level to guide you to getting the best exposure. It is discussed in detail in Topic 3–7.

- When the lens is set to manual focus (M or MF) AE lock is based on the center AF point.

- After locking exposure in Program AE (P) shooting mode you can turn the Main Dial to use program shift.

- Exposure is locked (AE lock) as long as you hold down the depth-of-field preview button.

Resources to Explore

1. Exposure Lock shows how you can lock exposure (and focus) on any part of a scene just by pointing the camera at it and pressing the shutter button halfway down. Without releasing the shutter button, you then compose the image the way you want it, and press the shutter button the rest of the way down to take the photo. www.photocourse.com/itext/explock.

2. Display Target 15 or 16 Picture with Grayscale in Appendix A full-screen. Set your camera to P, Av or Tv shooting mode and turn on Live View:

   - Set the camera to spot metering mode and Live View, then point the metering area at each step of the scale to see what happens to other steps. Watch the exposure settings on the monitor to see how they change.

   - Set the camera to evaluative metering mode then point at one of the steps on the scale, press and hold the shutter button halfway down to lock exposure and point at other steps. What happens when exposure is locked?

3. Display Target 18 Picture with Three Boxes in Appendix A full-screen. Set your camera to Program AE (P) shooting mode, spot metering and Live View.

   - Point the spot metering area at each of the three boxes as you watch the effect each box has on the overall exposure of the image. (You may have to press the shutter button halfway down for each box.)

   - Now point at one of the boxes, press the shutter button halfway down to lock exposure and point at the other boxes. What happens when exposure is locked?
Here the exposure was locked on the middle gray part of the wall and then the image was composed.

In both of these images exposure was locked on a white part of the scene, exposure compensation adjusted to lighten the image, and then the image was composed.
In this scene the exposure was locked on the middle gray street and then the image was composed and captured.

Here exposure was locked on the middle gray tombstone in the center of the image.
When you want to be absolutely certain you have the best exposure, autoexposure bracketing (AEB) takes a series of three photos—one at the exposure recommended by the camera and then one under exposed to be darker and one over exposed to be lighter. It’s basically an automated form of exposure compensation. On the 7D Mark II you can take three images up to 3 stops apart in steps of 1/2 or 1/3rd stop.

Autoexposure bracketing runs off three shots at different exposures. Here the sequence is +1 (left), 0 (center), and -1 (right).

The camera will display a readout of the shots to be taken in AEB. Here there are three shots, one stop apart. The three pictures will be taken at -1, 0 and +1.

Here exposure compensation was used to shift the three images to the plus side so they will be taken at 0, +1 and +2.

The AEB icon blinks on the LCD panel after you take the first photo in a series. An * does the same in the viewfinder.

The AEB icon blinks on the LCD panel after you take the first photo in a series. An * does the same in the viewfinder.

The screen used to the exposure increment between shots.

Tips

- The vertical exposure level indicator on the right side of the viewfinder shows the exposure level of the three photos and when you press the shutter button halfway down it shows which of the three is about to be taken.
- AEB stays in effect until you reset it to 0, turn the camera off or pop up the flash. If you don’t do one of these things, the camera remains set to this mode so subsequent pictures are captured at different exposure levels.
- You can’t use flash or bulb mode with AEB or use it when using Multi-shot noise reduction of HDR.
- If you use one of the continuous modes for autoexposure bracketing, the series of three shots is taken when you hold down the shutter button.

Using Autoexposure Bracketing (AEB)

1. With the Mode Dial set to P, Tv, Av or M, press the Quick Control button to display the Quick Control screen.
2. Press the Multi-controller to select the exposure level indicator then turn the Main Dial to expand or contract the exposure increment between shots and press SET.
   - The middle bar indicates the exposure recommended by the camera (or shifted with exposure compensation).
   - The left and right bars indicate by how many stops the other two images will be underexposed (-) and overexposed (+).
3. Take each of the three photos just as you normally would. As you do so the AEB icon on the LCD panel and the * in the viewfinder blink. When the series is complete, the flashing stops.
4. When finished, repeat Steps 1–2 to reset AEB to 0.
If you use the self-timer in AEB mode, all three photos are taken automatically after the specified delay.

While turning the Main Dial to set AEB, you can also turn the Quick Control Dial to set exposure compensation—shifting the three photos up and down the exposure level indicator.

You can also set AEB by displaying the Shooting 2 menu and selecting Expo. comp/AEB.

To lighten or darken images in the series the camera may change the aperture, shutter speed or both. Which it changes is determined by an algorithm and may depend on the situation.

To be sure you are bracketing using the aperture or shutter speed use Manual (M) shooting mode and make the adjustments manually.

Flash exposure bracketing (FEB) can be used to bracket flash exposures.

**Resources to Explore**

1. **Autoexposure Bracketing** (AEB) shows how AEB automates exposure compensation by taking 3 or 5 photos while the camera automatically varies the exposure for you at [www.photocourse.com/itext/AEB](http://www.photocourse.com/itext/AEB).

2. Search the Internet for “Autoexposure bracketing” to learn more about this feature.

**Seeing for Yourself**

1. Display Target 15 or 16 Picture with Grayscale in Appendix A full-screen. Set your camera to spot metering and Program AE (P). Set AEB to take 3 pictures 1 stop apart.
   - Point the spot metering area at one of the center steps on the scale and press the shutter button to take three pictures. Look at the three in playback mode to see which settings the camera changed. Is one of the exposures better than the others?
   - Point the spot metering area at any other step on the scale and press the shutter button to take three pictures. Look at the three in playback mode to see if the same settings changed. Is one of the exposures better than the others?

2. Repeat 1 above but first use exposure compensation to increase the exposure +1. How do the images captured this time differ from the first series?

3. In Playback mode press INFO so the shutter speed and aperture used are displayed. Scroll through your sets of 3 images to see which setting the camera changed. Notice how the + and - settings are displayed.

In this AEB series exposure decreases one stop between pictures. You can see the effect this has on both highlights and shadows.
If you have ever seen an original Ansel Adams print, you probably marveled at the way he used the entire tonal range to capture detail in both the highlights and shadows. His prints reflect the control he had over his images using the Zone System he developed with Fred Archer. By exposing and developing the sheet film following his strict rules, he could expand or contract the tonal range of the negative to more closely represent the tonal range of the scene. Although The Zone System is very technical, much of what it enabled you to do can now be accomplished with a digital camera and a photo-editing program such as Lightroom or Photoshop. The Zone System is based on the general principle that to retain detail you expose for the shadows and develop for the highlights. In digital photography, you expose so pixels aren’t clipped and on many cameras you can display a histogram to confirm that you have done this. You then use a photo-editing program to adjust the tones in the image so they fall in the desired zones.

To begin, you use exposure compensation to “place a value”. To do this, you select the most important part of the scene and meter it from close up or use spot metering mode. The key to metering a specific value is to have the area of the scene you are metering fill the camera’s metering area. You then decide what tone you want this area to have in the final image. Since autoexposure will make it middle gray, or Zone V, you may have to change the exposure to move it to another zone. In manual mode you can do this by changing the shutter speed or aperture. In other modes that support it, you use exposure compensation.

In the section How Overriding Autoexposure Works earlier in this chapter we listed some exposure compensation adjustments you could make and gave some examples. Minor White provided an expanded list of examples in his classic book “Zone System Manual: How to Previsualize Your Pictures”. They include the following:

### Low Values
- 0: Maximum black. The blackest part that a print can be made to yield. Doorways and windows opening into unlit rooms.
- I: The first discernible tone above total black. When seen next to a high key zone, it will be seen as total black. Twilight shadows.
- II: First discernible evidence of texture, deep tonalities which represent the darkest part of the picture in which a sense of space and volume is needed.
- III: Average dark materials and low values showing adequate texture. Black hair, fur, and clothes in which a sense of details is needed.

### Middle Values
- IV: Average dark foliage, dark stone, or open shadow in landscape. Normal shadow value for Caucasian skin portraits in sunlight. Also brown hair and new blue jeans.
- V: 18% Gray Neutral Test Card. Most black skin, dark skin or sunburnt Caucasian skin, average weathered wood, grass in sunlight, gray stone.
- VI: Average Caucasian skin value in sunlight, diffuse skylight, or artificial light. Light stone, shadows on snow in sunlit landscapes. The Caucasian face referred to is with the flat of the cheek at a 45° angle to the light source.

### High Values
- VII: Very light skin, light gray objects; average snow with acute slide lighting.
- VIII: Whites with texture and delicate values; textured snow; highlight on Caucasian skin.
- IX: White without texture approaching pure white, similar to Zone I in its slight tonality without a trace of texture.
- X: Pure white of the printing paper base, specular glare or light sources in the picture areas.
Chapter 3 Setting the Shutter Speed and Aperture

Tips

• It’s easier to judge zones when the scene is grayscale and free of distracting colors. On the 7D Mark II you can do this by setting the Picture style to Monochrome as described on page 160 in your camera’s Instruction Manual. After taking a test shot in this mode you can switch to RAW for higher image quality. You can also use the histogram as a guide.

• Camera histograms are never marked in stops or zones so it takes time to get familiar with where they fall on the horizontal axis.

• HDR and other tone expansion settings spread pixels over an image’s entire tonal range. You can also do the same using a photo-editing program to manipulate higher quality RAW images.

Resources to Explore

1. Search the Internet to learn more about the “Zone System”.
2. Search the Internet for “Tiffen B&W viewing filter” to learn more about the kind of filter film photographers use to see color scenes in black and white.

Seeing for Yourself

1. Display Target 19 or 20 Zone System Zones in Appendix A full-screen. Set your camera to spot metering mode and Live View. Point to one of the zones and use exposure compensation to shift it one zone lighter on the monitor. Shift it two zones darker.

2. Repeat 1 above but with the camera set to its grayscale mode if it has one. Is it easier to visualize the image tones?
Chapter 3 Setting the Shutter Speed and Aperture


Since a camera’s exposure system is designed to set the exposure to capture a middle gray scene you can get good exposures in many situations by using a card that’s exactly middle gray in color—reflecting 18% of the light that strikes it. You begin by completely filling the camera’s metering area with the card under the same light in which you will be shooting. When you press the shutter button halfway down to lock exposure and focus your camera selects settings for the best exposure regardless of how light or dark the scene is (you may have to press the shutter button halfway down to see this).

If you meter a gray card it will indicate the correct exposure because both the subject and the image to be captured are middle gray on average. Once you meter the card and know the correct settings you can switch to Manual (M) mode and set them.

You can now proceed in one of the following ways:

- Remove the gray card from the scene and set the camera to Manual (M) shooting and set the aperture and shutter speed to get the recommended exposure setting.
- Use AE Lock to retain the setting for the gray card, then remove the gray card, lock focus and take the picture of the subject.
- Leave the gray card in the scene for one of your trial shots. Later, you can use it in your photo-editing program to determine the correct exposure and white balance and then apply necessary corrections, if any, to the rest of the images shot under the same light. For example, in Photoshop you just open the image and use Image > Adjustment > Levels menu settings to display a dialog box with three eyedroppers. Select the middle eyedropper and use it to click the gray card in the image and the image’s exposure and color balance should be corrected.

Opteka Digital Grey Card set has a white, black and gray card.

**Tips**

- To make middle gray in Photoshop, display the Color Picker and set R, G and B values to 127. You can then select an area and use the Paint Bucket Tool to fill it with that tone.

**Resources to Explore**

1. Search the Internet for the term “gray card” to see what you can learn about these useful exposure aides and see the kinds available.
2. Search the Internet for “creating middle gray in Photoshop”.
3. Search the Internet for “zone system zone V” to see what you can learn about middle gray in the Zone System.
**Seeing for Yourself**

1. Find a close-up you’d like to capture and set the camera to spot metering and Manual (M) shooting mode. Put a gray card in the scene and while it fills the metering area adjust the exposure so it matches the one recommended by the camera. Remove the gray card and take the picture. Now put the camera on Scene Intelligent Auto shooting mode and take another picture of the same scene. Compare the two photos to see which has the better exposure.

2. Display Target 15 or 16 *Picture with Three Boxes* in Appendix A full-screen. Set your camera to program auto (P) shooting mode and spot metering. Point the metering area at the white, gray and black boxes while watching how the scene appears on your camera’s monitor. The grey box which is middle gray should give the best exposure.

3. If you have a gray card, set your camera to Manual (M) shooting mode and adjust the aperture and shutter speed to get the recommended exposure. Take a photograph of the card to see if the tone of the image matches the tone of the card.

*A middle gray background is like having a large gray card.*

*A gray card in one of your shots will make it easy to arrange the color balance of all of the shots taken under the same light.*
The distribution of tones on an image’s histogram can be adjusted in the camera during shooting or later in a photo-editing program. The tonal controls in the 7D Mark II include Highlight Tone Control, Auto Correction of Brightness and Contrast, High dynamic range (HDR) and Auto Lighting Optimizer.

These settings, which you can find by searching your camera’s Instruction Manual, either automatically evaluate the scene and make adjustments or let you select preset tonal curves. Their purpose is to spread tones across the entire tonal range while retaining details in the shadow and highlight areas so they aren’t clipped to pure black or white. They work primarily on JPEG images but there are computer programs that adjust the tonal range of RAW images. They include Digital Photo Professional that comes with your camera and Photoshop.

One of the most promising tone controls is called High Dynamic Range (HDR). This works by capturing a series of photos at slightly different exposures. These images are then combined digitally so the best exposed parts of each are used to create a single well-exposed image. Because multiple images are taken, this setting works best with static scenes and with the camera mounted on a tripod. However, the camera will automatically align images before merging them so you should get good results even with hand-held sequences.

Photoshop makes the following recommendations for the best results when shooting images for HDR. The 7D Mark II meets all of the relevant suggestions.

- Use a tripod.
- Take enough photos to cover the full dynamic range of the scene but the minimum number is three.
- Vary the shutter speed to change exposures. Changing the aperture changes the depth of field in each exposure and can produce lower-quality results. Changing the ISO or aperture may also cause noise or vignetting in the image.
- In general, don’t use AEB, because the exposure changes are usually too small. The exposure differences between the photos should be one or two stops.
- Don’t vary the lighting from one image to the next.
- Make sure that nothing is moving in the scene.

Although we recommend shooting RAW and then using PhotoShop or some other photo-editing program to merge your images, you can do HDR JPEGs in the camera. The 7D Mark II’s HDR mode captures three images at different exposures (standard exposure, underexposure, and overexposure) when are then merged automatically. The camera can save both the three images in the series.
and the composite JPEGs. When using this feature you can adjust the following settings:

- **Adjust dyn range** specifies the exposure increment between the three shots and turns on HDR when you select one. The higher the number, the wider the dynamic range will be. To exit HDR shooting from this setting, select **Disable HDR**.

- **Effect** specifies how your JPEG images will be permanently altered. For our purposes **Natural** is the best choice because it’s designed to preserve highlight and shadow details would otherwise be lost.

- **Continuous HDR** can be set to **1 shot only** or **Every shot**. When set to **1 shot only** HDR shooting is turned off automatically when shooting ends. With **Every shot**, HDR shooting continues until the setting is set to **Disable HDR**.

- **Auto Image Align** should be **Enabled** for handheld shooting so the camera can automatically align your images, and set to **Disabled** when using a tripod.

- **Save source imgs** can be set to save all three images and the merged HDR image, or to save only the composite HDR image.

**Using HDR**

1. With the camera in P, Tv, Av or M shooting mode press the Creative photo button, turn the Quick Control dial to highlight **HDR**, and press SET to display the HDR menu with a settings you can use as is or change.

2. Change any of the settings discussed above.

3. Turn on HDR by setting **Adjust dyn range** to any setting other than **Disable HDR**.

4. Take the picture. When you press the shutter button completely, three consecutive images are captured, and the composite HDR image is saved as a JPEG.

5. To disable HDR if you set **Continuous HDR** to **Every shot** repeat Steps 1–3 but select **Disable HDR**.

**Tips**

- If the image quality is set to RAW, the HDR image will be saved as a large fine JPEG. If the image-recording quality is set to RAW+JPEG, the HDR image will be recorded in the specified JPEG quality.

- HDR can be used between ISO 100–ISO 16000 and to prevent camera shake, a high ISO speed may be used.

- The flash is disabled during HDR shooting.

- During HDR shooting Distortion, Auto Lighting Optimizer, Highlight tone priority, Expo. simulation and AEB are disabled.

- A moving subject may appear as afterimages because it’s not in the same position in all three images.

- Adobe’s Photoshop has a “Merge to HDR” feature that combines your series of images to create a single HDR image.

- The results of HDR can vary and may also affect the colors in an image, sometimes giving it an unrealistic, almost fantasy-like, effect.

**Resources to Explore**

1. Search the Internet for the phrase “digital camera tone controls” to see what you can learn about these techniques.

2. Search the Internet for the phrase “high dynamic range” and “HDR” to see what images and information you can find on this technique including software applications you can use to merge your multiple images into one.

3. Search the Internet for information on “tone curves” and also precede the search terms with your camera make and model such as “Canon 7D Mark II tone curves”.

**Seeing for Yourself**

1. Display Target 15 or 16, Picture With Grayscale in Appendix A full-screen. Set the camera to spot metering and RAW image quality.

   - Point the spot metering circle at the middle grey step and take a photo.

   - Set your camera to one of its tone controls and JPEG image quality then photograph the image the same way.

   Enlarge the two images and compare their tonal ranges especially in the very dark and very white steps.

2. Use HDR to capture a high contrast scene. In playback mode with the histogram displayed scroll through the four images to see what they look like and compare their histograms.
Robert Frank on the Road

Photographers have always taken road trips including those who documented the American West in the mid 1800s. Among the most creatively productive were the three car trips taken in the mid 1950s by Robert Frank that resulted in the publication of his classic book “The Americans”. On his trips Frank took about 27,000 images from which he made 1,000 work prints. After spreading them on the floor and hanging them on the walls of his studio, to live with them for awhile, he finally selected just 83 images for the book. In this project you first examine Frank’s photos in his book or on the Internet. As you study them for the first time they may feel familiar but that’s because they influenced so many photographers who followed. At the time they were made they presented a clean break with the past. You’ll also notice how little effect grain (noise) and blurriness have on the quality of a photo if it’s content is strong.

After studying these pictures, take a short road trip by car or public transport, as long as it’s to an area where you’ve never been before. Using your fresh eyes, photograph the area in such a way that people looking at your photos will get a good idea of what the area and the people in it are like. Assemble the best five photos to share.

Walker Evans on a NYC Block

Road trips don’t have to be long, in fact they can often be made on foot. In this project you first study an exhibition of the photos Walker Evans took on a block in New York City where he lived at the time. He photographed everything including the neighborhood’s residents, streets, signs, and buildings. Using what you learn from studying the photos, take a walk around your own neighborhood and document it the way Evans did his. To begin, click the following link to see Walker Evans work at [memory.loc.gov/ammem/fsahml/fachap04.html](http://memory.loc.gov/ammem/fsahml/fachap04.html). After documenting the neighborhood, select the best photos to share.
Many photographers try to improve their photography by following a set of rules, generally about composition. However, rules are polarizing. Many photographers dismiss them as simplistic and formulaic. One of the best quotes from this camp was Edward Weston’s “Consulting the rules of composition before taking a photograph, is like consulting the laws of gravity before going for a walk”. Whatever your opinion about their value, search the Web for “rules of photography” and list some of the rules you find. Using what you learn, try taking one photo following one or more of the rules and describe which rules you applied.

An example of the rule of thirds applied to a landscape.

**Cues to Depth**

When we look at scenes our brains use visual cues to judge depth. Many of those cues are listed following. After reading them try taking some photos that use one or more of them. The more you can use in a single image, the more depth it will appear to have.

- The occlusion of more distant objects by closer ones.
- Perspective from parallel lines such as railroad tracks converging into the

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An illustration from an article Ansel Adams wrote on “Geometrical Approach to Composition” in “The Encyclopedia of Photography” Vol 9 goes perhaps a bit too far on analyzing composition.
distance.

- Scale, or angular size, lets us perceive the distance of subjects with known heights. The apparent size as objects changes as they get closer or farther away.
- Shading and shadows that delineate the shape of objects.
- Aerial perspective that blurs and softens more distant subjects.
- Motion parallax that shows the relationship of subjects as you move through a scene or move your head from side to side.
- Change in size of texture and patterns.
- Vertical position that leads us to believe taller objects are further away.

The only depth cues that stereo vision adds are parallax and accommodation—the refocusing of the eyes as their vision shifts from one distance plane to another.

This photo has four cues to depth—scale, occlusion, perspective and aerial perspective.

Here the diminishing size of the bikes indicates depth in the image as they also point toward the figures in the background.

Convergence indicates depth.
Cheap Tricks

Many cameras now include a number of special effects settings that manipulate your images. For example, some can make them look as if they were taken by a toy camera or making buildings look miniaturized—as if they are part of a scale model train set. Smart phone apps have pushed the frontier of this kind of photography to new limits. If your camera or smartphone has these effects try them. For example, if you have a grayscale mode, sometimes called B&W, you might try emulating the Leica photographers of the 1930s while doing some street photography. If it has sepia mode, try the same with landscapes like those take in the 19th century of architectural details and abandoned artifacts.

A Self-Portrait

Philip Perkis in his classic book “Teaching Photography” (available on Amazon) recommends that every student of photography take a self-portrait. Not only does this get you out from behind the camera, it also connects you with the history of photography during which self-portraits have been a recurring theme. One of the first self-portraits was taken in 1839, just after the invention of photography, by Robert Cornelius in Philadelphia. Exposures in those days were so long he was able to start it, get in front of the camera, and then get back to the camera to end the exposure. Today you can use a self-timer, photograph your shadow or reflection or do as Lee Friedlander did and hold the camera out in front pointing back at you. Search the Internet for “portrait photography” “self-portrait photography” or “self-portraiture” to learn more about this historical form of photography. One person to look up is Arno Minkkinen who captures some of the most amazing self-portraits in photography. Another is Self Portrait: Photographs by Lee Friedlander. To see examples of Friedlander photographing his own shadow search the Internet for “Lee Friedlander shadows”. Finally check out Karl Baden’s self-portraits where, since February 23rd, 1987, he has photographed his. You can see the photos at kbeveryday.blogspot.com.

Robert Cornelius, self-portrait; believed to be the earliest extant American portrait photo. Courtesy of the Library of Congress.
Emulating Muybridge

Eadweard Muybridge is famous for his animal locomotion photographs that used multiple cameras and trip wires to capture moving subjects, what we today call continuous mode. One of his most famous series proved that when a horse galloped all four feet left the ground at the same time, something that happened so fast it couldn’t be discerned with the naked eye. Search the Internet for information on Muybridge and view his images. When ready, find a moving subject you can photograph in a single burst in continuous mode. Muybridge invented the zoopraxiscope to display his images of a subject one after another to show them much like an early movie. (www.photocourse.com/itext/muybridge/muybridge.gif) You can do the same with your series by turning it into an animated GIF. To begin search your photo-editing program’s help system for “GIF” to see if it can create animated GIFs and if so, how you do it. If your photo-editing program won’t create an animated GIF, search the Internet for “animated gif shareware” to find one of the many free programs that will. There are also Web sites such as makeagif.com where you can create gifs from your own images.

Movies

Many photographers have moved back and forth between still photography and film. Three of the best were Ralph Steiner, Paul Strand and Leo T. Hurwitz who worked together in the 1930s on a classic documentary film with Pare
Lorenz. Called “The Plow that Broke the Plains”. The film is widely available on-line at sites such as YouTube and gives you an idea of how a great photographer frames shots. Despite the quality of their work Lorenz fired all three when they went on strike over a number of issues. (While viewing this movie you might also want to search for and view some of the earliest films such as “Arrival of a Train at La Ciotat” and the work of Georges Méliès who was featured in the movie Hugo.)

Using what you’ve seen from the early days of filmmaking try using your camera’s movie mode to create your own short film of a minute or two in length and see if you can make it interesting to others. Upload the film to YouTube or another video site of your choosing.

Shooting in Black and White

Ansel Adams, Minor White and other Zone System photographers recommended looking at a scene through a deep amber filter to see it in black and white. (Search the Internet for the “Tiffen #1 viewer” for black-and-white imaging.) This made it easier to see the tones without the distractions of the colors. If your camera has a shooting mode that captures grayscale images and displays histograms in shooting and playback modes you have much better tools to work with than earlier photographers ever imagined. In this project you use your camera and a gray card to place values in a scene. To begin set your camera to spot metering and B&W shooting mode, if it has it, or Program AE (P) if it doesn’t. Display Target 19 or 20 Zone System Zones in Appendix A full-screen and do as follows:

1. Point the spot metering area at Zone V on the target and notice how the histogram shows the majority of pixels to be grouped around middle gray.
2. Point at Zone VI and using exposure compensation, make it look exactly like
Zone V did. You have now placed a Zone VI subject in Zone V in the image.
3. Continue exploring exposure compensation and placing values on the target then go out and find some real world scenes to continue practicing on.

### Interesting Histograms

Display Target 13 *Black and White* in Appendix A full-screen. Set your camera to Program AE (P) shooting mode and display a histogram.
1. Use spot metering to display a histogram of first the white part and then the black part.
2. Switch to evaluative metering and fill the frame with the card to display its histogram.

Explain the three histograms and why they are the way they are.

### Interesting Stories

Dorothea Lange’s photo of the “Migrant Mother” is, according to a manager at the Library of Congress, where the image remains one of the most requested items in the photography collection, “It’s the most striking image we have; it hits the heart…. an American icon”. In this project, you search the Internet or visit [www.press.uchicago.edu/Misc/Chicago/316062.html](http://www.press.uchicago.edu/Misc/Chicago/316062.html) to see how the woman in the photo, Florence Owens Thompson, felt about it. It’s rare to hear from the subject of such an iconic photo.

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Dorothea Lange’s photo of destitute pea pickers in California. Mother of seven children. Age thirty-two. Nipomo, California The photo is referred to as the “migration mother”. [www.press.uchicago.edu/Misc/Chicago/316062.html](http://www.press.uchicago.edu/Misc/Chicago/316062.html).

### HDR

In the earliest days of photography, if a photographer exposed a landscape or
seascape for the foreground, the skies would be too bright and burned out. In the 1850s the French photographer Gustave Le Gray started taking two exposures of each scene—one of the foreground and one of the sky. He then used the two negatives while making prints so he retained details in both areas. Today, High Dynamic Range (HDR) photography uses the same basic concept—combining a series of photos taken at slightly different exposures to get one image with an expanded tonal range. It's a very simple process that can have dramatic results. In this project you explore this process in some depth.

1. First, decide what software you will need to combine the images. There are cameras that will process the images in the camera, plug-ins for popular photo-editing programs such as Photoshop and Lightroom, and stand alone programs. If your camera or photo-editing program won't create HDR images for you, look for a trial version from a company such as hdrsoft.com. Once you have the software read about how you use it.

2. Find a static scene that has a wide tonal range including deep shadows and bright highlights and set the camera up on a tripod so it can’t move between or during exposures.

3. Take a picture of the scene as you normally would so you have a comparison shot.

4. Now capture your HDR images as follows:
   - If the entire process is going to be done in the camera, select the HDR shooting mode as described in your camera’s user guide.
   - If you are capturing images to be processed on the computer use the camera’s Manual (M) shooting mode and change the shutter speed to adjust exposures.

6. Use the camera’s self-timer or a remote release to trigger the sequence of photos.

Once you have the images, if your are using the camera’s HDR mode, they are combined automatically. If you are using software on your computer follow it’s instructions to combine the images. Compare the finished image to the one you shot normally.

Finding Details

Walker Evans photographed all kinds of posters, both in their entirety and zooming in on details where tears and peeling created new images. This same idea was explored later by photographers such as Minor White and Aaron Siskind who photographed abstracts ranging from peeling paint to growth on rocks. Search the Internet for both Aaron Siskind and Minor White to become familiar with their work, then photograph some similar subjects on your own.

Posters covering a building near Lynchburg to advertise a Downie Bros. circus taken by Walker Evans in 1936. Courtesy of Library of Congress.
