Barbara LONDON | Jim STONE

A Short Course in Photography

FILM and DARKROOM

Tenth Edition

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A Short Course in PHOTOGRAPHY

Film and Darkroom

AN INTRODUCTION TO PHOTOGRAPHIC TECHNIQUE

Elaine O'Neil

Barbara London ■ Jim Stone

Pearson

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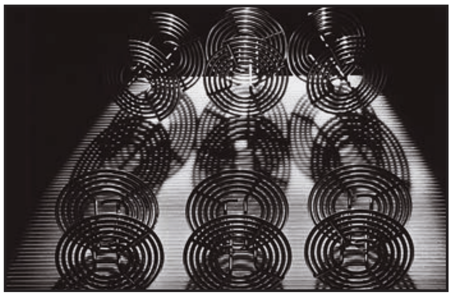
Contents



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Preface

If you don't know anything about photography and would like to learn, or if you want to make better pictures than the ones you make now, *A Short Course in Photography* will help you. It presents in depth the techniques for black-and-white photography, and the basics of color and digital:

- How to get a good exposure.
- How to adjust the focus, shutter speed, and aperture (the size of the lens opening) to produce the results you want.
- How to develop film and make prints in a darkroom.
- How to use a digital camera and make photographs using digital editing on a computer.

Almost all of today's cameras incorporate automatic features, but that doesn't mean that they automatically produce the results you want. *A Short Course in Photography* devotes special attention to:

- Automatic focus and automatic exposure—what they do and, particularly, how to override them when it is better to adjust the camera manually.

Some of the book's highlights include:

- Getting Started. If you are new to photography, this section will walk you through selecting and loading film or a memory card, focusing sharply, adjusting the exposure, and making your first pictures. See pages 4–11.
- Digital Photography. Digital imaging may be just another tool, but it is also an immensely powerful technique that has changed photography and empowers those who know how to use it. See pages 140–169.
- Projects. These projects are designed to help develop your technical and expressive skills. See page 124 or 173.
- Making Better Prints. Includes information about how to fine tune your prints by burning in and dodging (darkening or lightening selected areas), and by cropping the edges to concentrate attention on the portion of the scene you want. See pages 112–114.
- Types of lenses, types of film, lighting, and filters.

Photography is a subjective and personal undertaking. *A Short Course in Photography* emphasizes the choices you can and should make every time you capture an image:

- How to look at a scene in the way a camera can record it.
- How to select the shutter speed, point of view, or other elements that can make the difference between an ordinary snapshot and an exciting photograph.
- Chapter 9, Seeing Like a Camera, explores choices in selecting and adjusting the image, and offers insights into photographing familiar subjects such as people and landscapes.

New to this edition are:

- Updated Chapter 8, Digital Photography, includes the latest camera technology and software, and integrates Photoshop with workflow applications.
- Many new photographs by great contemporary artists, including Sam Comen, Adam Ekberg, Kate Joyce, David Leventi, Martina Lopez, Christoph Oberschneider, Todd Owyoung, Geoffrey Robinson, and Ian van Coller.
- An updated Chapter 10, The History of Photography, traces the technical, social, and artistic development of the medium since its inception.
- Technical updates and current product information throughout.
- The latest information on Health and Safety precautions in the darkroom.

This book is designed to make learning photography as easy as possible:

- Every two facing pages completes a single topic.
- Detailed step-by-step instructions clarify each stage of extended procedures, such as negative development and printing.
- Boldfaced headings make subtopics easy to spot, and page cross-references point out more on each subject.
- Numerous photographs and drawings illustrate each topic.

Acknowledgments

Many people gave generously of their time and effort in the production of this book. Feedback from instructors helps confirm the direction of the book and determine the new elements in each edition. The authors are grateful to all those who reviewed previous editions and forwarded comments. At Pearson Education, Roth Wilkofsky provided editorial support. Annemarie Franklin, Steve Martel, and the team at SPi Global supervised the production of the book from manuscript to printer and caught our (extremely few, of course) errors. Amber, Jade, and Skye Stone gave their dad time to finish the book. If you have suggestions, please send them to Photography Editor, Pearson Education, 221 River Street, Hoboken, NJ 07030. They will be sincerely welcomed.

Jim Stone
Barbara London

ANNIE LEIBOVITZ

Yo Yo Ma, 1998. ***Framing is a basic control*** *you have in making a photograph. The two photographs on this page and opposite are about music. Would you center your subject or use a corner? Do you want action or repose? Black and white or color? Horizontal, vertical, or square? Candid or posed? Looking at the subject from above, below, or straight on?* *More about framing on pages 172–173.*

Camera  1

All cameras have four things in common: an image-forming lens; a light-sensitive surface (film or a digital sensor) to record the light that forms an image; a light-tight container (the camera's body) to keep other light out; and two important controls to adjust the amount of picture-making light (the exposure) that reaches the light-sensitive surface.

This chapter describes those light controls and how you can take charge of them, instead of letting them control you. Almost all current cameras are equipped with automatic exposure and automatic focus, and most have automatic flash. If you are interested in making better pictures, however, you should know how your camera makes its decisions, even if the automatic features can't be turned off. If they can, you will want to override your camera's automatic decisions from time to time and make your own choices.

- You may want to blur the motion of a moving subject or freeze its motion sharply. Pages 18–19 show how.
- You may want a scene sharp from foreground to background or the foreground sharp but the background out of focus. See pages 40–43.
- You may want to override your camera's automatic focus mechanism so that only a certain part of a scene is sharp. Page 41 tells when and how to do so.
- You may decide to silhouette a subject against a bright background, or perhaps you want to make sure that you don't end up with a silhouette. See page 72.

Most professional photographers use cameras with automatic features, but they know how their cameras operate manually as well as automatically so they can choose which is best for a particular situation. You will want to do the same because the more you know about how your camera operates, the better you will be able to get the results you want.

Project:

EXPOSE SOME PICTURES

YOU WILL NEED

Camera. We suggest a digital or 35mm film single-lens reflex.

Film or digital output. To evaluate your work, it's good to see exactly what you did. Slides can be projected so you can easily see small details. Digital pictures can be displayed unedited on a monitor.

If using film, page 4 tells how to choose one. The accuracy of your exposure will be easier to see if you shoot slides for this project because slide development does not compensate for exposure errors that make pictures too light or too dark, the way printing can. Developing and printing black-and-white film is coming in later chapters.

If you expect to work with black-and-white film, you can use Kodak T-Max 100 for this project and process it with Kodak's T-Max 100 Direct Positive Film Developing Outfit. Be sure to read all instructions before exposing the film. If you shoot color slides, it will be harder to imagine what the picture would have looked like in black and white.

Pencil and notepad to keep track of what you do. Optional, but highly recommended for all the projects.

PROCEDURE See pages 4–9 if you are just beginning to photograph. Those pages walk you through the first steps of setting up your camera, focusing an image sharply, adjusting the camera settings so your photographs won't be too light or too dark, and making your first pictures. See pages 10–11 for more about digital cameras.

Have some variety in the scenes when you shoot. For example, photograph subjects near and far, indoors and outside, in the shade and in the sun. Photograph different types of subjects, such as a portrait, a landscape, and an action scene. Page 9 gives some suggestions.

HOW DID YOU DO? Which pictures did you like best? Why? Were some different from what you expected to get? Did some of your camera's operations cause confusion? It helps to read your instruction book all the way through or to ask for help from someone familiar with your camera.

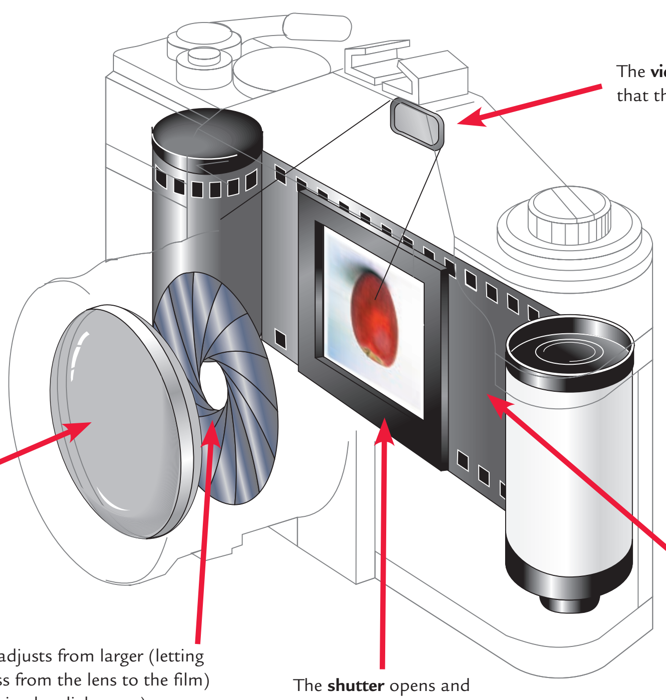
Todd Owyoung
Drummer Questlove performing with the Roots, Fox Theater, St. Louis, Missouri, 2008.

Getting Started

CAMERA AND FILM

A camera's main functions are to help you **view** the scene so you can select what you want to photograph, **focus** to get the scene sharp where you want it to be, and **expose** the light-sensitive surface (film or a digital sensor) so the picture is not too light or too dark.

A camera that uses film is shown here. Film is a transparent plastic surface coated with a light-sensitive **emulsion** (see Chapter 3). If you are using a digital camera (see pages 10–11).



The **viewfinder** shows the picture that the lens will focus on the film.

The **lens** can be moved forward and back to bring objects at different distances into sharp focus. If you have a manual-focusing lens, rotate its collar to move it.

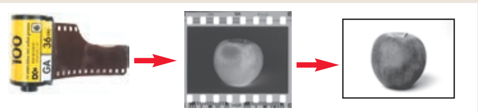
The **film** records the image transmitted by the lens.

The **aperture** adjusts from larger (letting more light pass from the lens to the film) to smaller (letting less light pass).

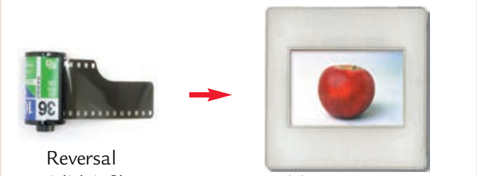
The **shutter** opens and closes to limit the length of time that light strikes the film.

More about camera controls on pages 16–23.

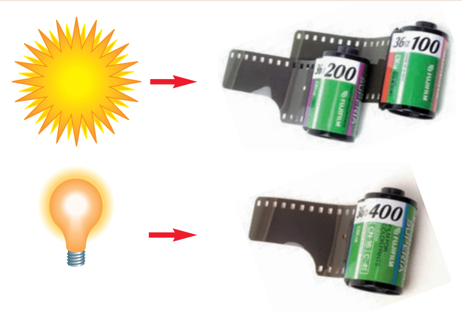
Choose a Film



If you want prints, select a negative film, either color or black and white. Developing the film produces a negative image, which is then printed onto paper to make a positive.



If you want slides (also called transparencies), which are positive images made directly from the film that is in the camera, select a reversal film. Most reversal films are for color.

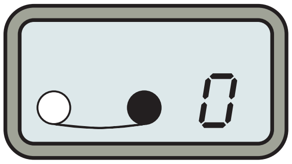


Film speed (ISO 100, 200, and so on) describes a film's sensitivity to light. The higher the number, the less light it needs for a correct exposure (one that is not too light or too dark). Choose a film with a speed of 100 to 200 for shooting outdoors in sunny conditions. In dimmer light, such as indoors, use film with a speed of 400 or higher.

More about film characteristics on pages 52–55.

LOADING FILM INTO THE CAMERA

Open the Camera



Make sure there is no film in the camera before you open it. Check that the film frame counter shows empty or that your camera's film rewind knob (if it has one) rotates freely. If there is film in the camera, rewind it (page 8).

A camera that loads film automatically probably will have a release lever to open the camera. Turn on the camera's main power switch. Open the camera back by sliding the release lever to its open position.

A camera that loads film manually will use its rewind knob at the top, not a release lever, to open the camera for loading. This type of camera usually opens for loading when you pull up on the rewind knob.

Insert and Thread Film

Keep film out of direct sunlight. Load film into the camera in subdued light or at least shield the camera from direct light with your body as you load it.

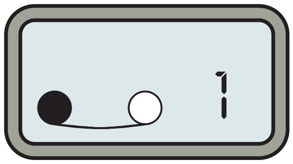
Insert the film cassette. A 35mm single-lens reflex camera usually loads film in the left side of the camera with the extended part of the cassette toward the bottom. The film should lie flat as it comes out of the cassette; if needed, rotate the cassette slightly to the right.

Automatic loading. Pull out the tapered end of the film until it reaches the other side of the camera. Usually a red mark or other indicator shows where the end of the film should be. The film won't advance correctly if the end of the film is in the wrong position.

Manual loading. Push down the rewind knob. Pull out the tapered end of the film until you can insert it into the slot of the take-up spool on the other side of the camera. Alternately press the shutter release button and rotate the film advance lever until the teeth that advance the film engage the sprocket holes securely at the top and bottom of the film and any slack in the film is reeled up by the take-up spool.

Advance Film to the First Frame

Close the camera back. The part of the film that you pulled out of the cassette has been exposed to light. You'll need to advance the film past this exposed section to an unexposed frame.



Automatic film advance. Depending on your camera, you may simply need to close the camera back to have the film advance to the first frame. Some cameras require you to also depress the shutter button.

If the film has correctly advanced, the film frame counter will display the number 1. If it does not, open the camera back and check the loading.

Manual film advance. With the camera back closed, alternately press the shutter release button and rotate the film advance lever. Repeat two times.

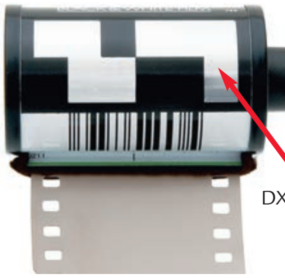
If the film is advancing correctly, the film rewind knob will rotate counterclockwise as you move the film advance lever. If it does not, open the camera and check the loading. Don't rely on the film frame counter; it may advance even though the film does not.

Getting Started

FOCUSING AND SETTING THE EXPOSURE

Set the ISO

Film speed. Set the camera to the speed (ISO) of the film you are using. Film speed is marked on the box and on the film cassette.



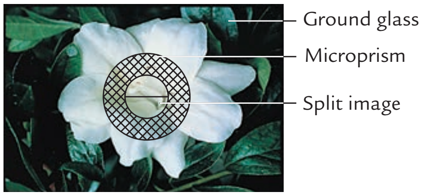
Automatically setting the film speed. Some cameras set the film speed as the film is loaded. The film must be DX coded, its ISO marked with a bar code that is read by a sensor in the camera. DX-coded films have “DX” printed on the cassette and box.

Manually setting the ISO. On some cameras, you must set the film speed manually. Turn the film speed dial (marked ISO or sometimes ASA) to the speed of your film. Here it is set to a film speed of 100.

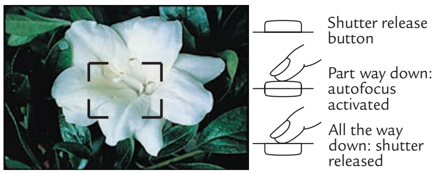
More about film speed on pages 54–55.

Focus

Focus on the most important part of your scene to make sure it will be sharp in the photograph. Practice focusing on objects at different distances as you look through the viewfinder so that you become familiar with the way the camera focuses.



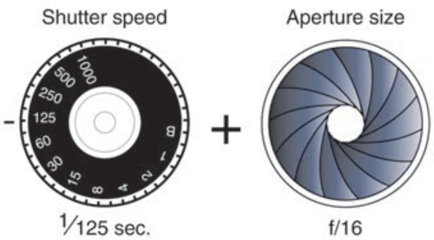
Manual focusing. As you look through the viewfinder, rotate the focusing ring at the front of the lens. The viewfinder of a single-lens reflex camera has a ground-glass screen that shows which parts of the scene are most sharply focused. Film cameras often have a microprism, a small ring at the center of the screen in which an object appears coarsely dotted until it is focused, or split-image focusing, in which part of an object appears offset when it is out of focus.

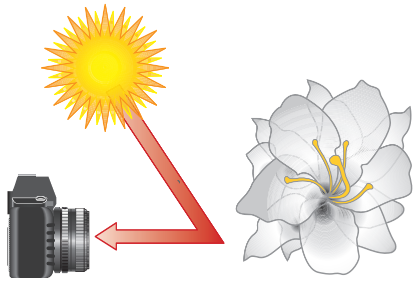


Automatic focusing. Usually this is done by centering the focusing brackets (visible in the middle of the viewfinder) on your subject as you depress the shutter release part way. The camera adjusts the lens for you to bring the bracketed object into focus. Don’t push the shutter release all the way down until you are ready to take a picture.

More about focus and when and how to override automatic focus on page 39.

Set the Exposure



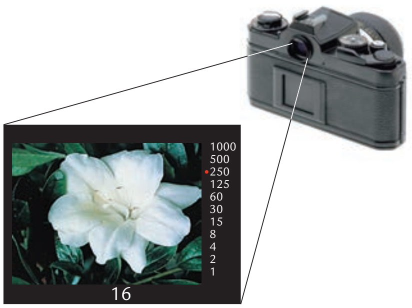


To get a correctly exposed picture, one that is not too light (overexposed) or too dark (underexposed), you—or the camera—set the shutter speed and the aperture depending on the sensitivity of the film (its ISO speed) and how light or dark your subject is. The shutter speed determines the length of time that light strikes the film; the aperture size determines how bright the light is that passes through the lens and shutter to the film.

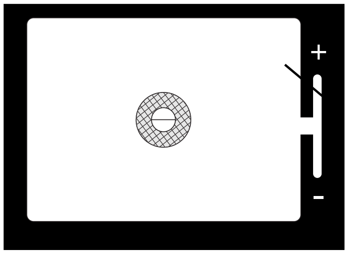
More about shutter speed and aperture on pages 18–23 and about exposure and metering on pages 61–75.

Exposure Readout

A data panel appears on the body of some cameras, displaying shutter speed and aperture settings (here, 1/250 sec. shutter speed, f/16 aperture), as well as other information.



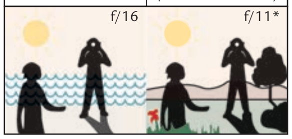
The shutter speed and aperture settings appear in the viewfinder of some cameras. Here, 1/250 sec. shutter speed, f/16 aperture.



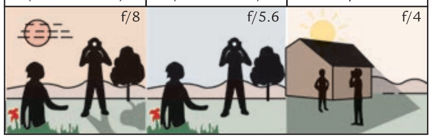
This needle-centering display in the camera's viewfinder doesn't show the actual shutter speed and aperture settings, but it does show when the exposure will be correct. You change the shutter speed and/or aperture until the needle centers between + (overexposure) and – (underexposure).

Manually Setting the Exposure

ISO 100: Average subjects outdoors	
Shutter speed 1/250 second	
Bright or hazy sun on sand or snow	Bright or hazy sun (distinct shadows)
f/16	f/11*



Shutter speed 1/125 second		
Weak, hazy sun (soft shadows)	Cloudy bright (no shadows)	Open shade or heavy overcast
f/8	f/5.6	f/4



*f/5.6 for backlighted close-up subjects. Subject shaded from sun but lighted by a large area of sky.

With manual exposure, you set both the shutter speed and aperture yourself. How do you know which settings to use? At the simplest level, you can use the chart above. Decide what kind of light illuminates the scene, and set the aperture (the f-number shown on the chart) and the shutter speed accordingly.

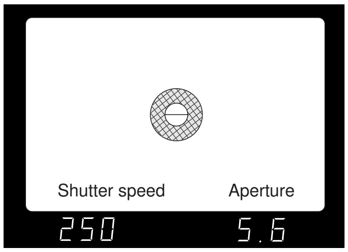
Notice that the recommended shutter speeds on the chart are 1/250 or 1/125 sec. These relatively fast shutter speeds make it easier for you to get a sharp picture when hand holding the camera (when it is not on a tripod). At slow shutter speeds, such as 1/30 sec. or slower, the shutter is open long enough for the picture to be blurred if you move the camera slightly during the exposure.

You can use a camera's built-in meter for manual exposure. Point the camera at the most important part of the scene and activate the meter. The viewfinder will show whether the exposure is correct. If it isn't, change the shutter speed and/or aperture until it is. Here, an arrow pointing up signals overexposure, an arrow pointing down means underexposure. The dot in the center lights up when the exposure is right.

To prevent blur caused by the camera moving during the exposure (if the camera is not on a tripod), select a shutter speed of at least 1/60 sec. A shutter speed of 1/125 sec. is safer.

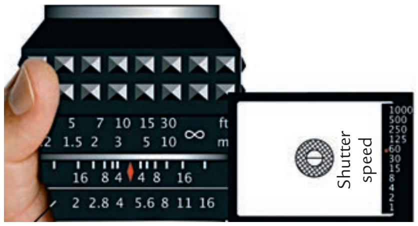
Automatically Setting the Exposure

With automatic exposure, the camera sets the shutter speed or aperture or both for you.



With programmed (fully automatic) exposure, each time you press the shutter release button, the camera automatically meters the light then sets both shutter speed and aperture.

With shutter-priority automatic exposure, you set the shutter speed and the camera sets the aperture. To prevent blur from camera motion if you are hand holding the camera, select a shutter speed of 1/60 sec. or faster.



With aperture-priority automatic exposure, you set the aperture and the camera sets the shutter speed. To keep the picture sharp when you hand hold the camera, check that the shutter speed is 1/60 sec. or faster. If it is not, set the aperture to a larger opening (a smaller f-number).

More about how to override automatic exposure on page 66.

Getting Started

EXPOSING THE FILM

Hold the Camera Steady

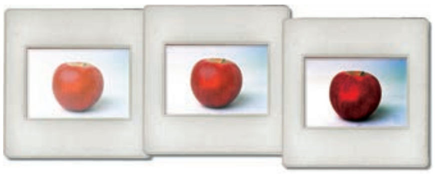
For horizontal photographs (sometimes called *"landscape"* mode), keep your arms against your body to steady the camera. Use your right hand to hold the camera and your right forefinger to press the shutter release. Use your left hand to help support the camera or to focus or make other camera adjustments.

For vertical photographs (*"portrait"* mode), support the camera from below in either your right or left hand. Keep that elbow against your body to steady the camera.

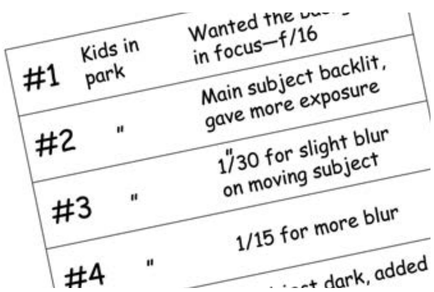
A tripod steadies the camera for you and lets you use slow shutter speeds, such as for night scenes or other situations when the light is dim. Make sure to use a cable release with it.

Expose the Film

Make an exposure. Recheck the focus and composition just before exposure. When you are ready to take a picture, stabilize your camera and yourself and gently press the shutter release all the way down. Most cameras prefocus automatically when you press the shutter button halfway down.

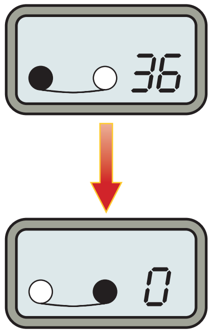


Make some more exposures. Try several different exposures of the same scene, lighter and darker, or perhaps from different angles. See opposite page for some ideas.

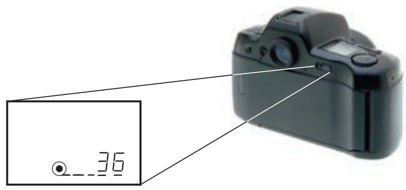


You'll learn faster about exposure settings and other technical matters if you keep a record of your exposures. For example, write down the frame number, subject, f-stop and shutter-speed settings, direction or quality of light, and any other relevant information. This way you won't forget what you did by the time you develop and print the film.

At the End of the Roll, Rewind the Film



After your last exposure on the roll, rewind the film back into the cassette before opening the camera. Store film away from light and heat until it is developed.



Automatic rewind. Most cameras automatically rewind the film after you make the last exposure on the roll, or the camera may signal the end of a roll and then rewind when you press a film rewind button.

Manual rewind. You'll know that there is no more film left on the roll when the film advance lever will not turn. The film frame counter will also show the number of exposures you have made: 36, for example, if you used a 36-exposure roll of film.

Activate the rewind button or catch at the bottom of the camera. Lift the handle of the rewind crank and turn it clockwise until tension on the crank releases.

WHAT WILL YOU PHOTOGRAPH?

Bob Simons

Where do you start? One place to start is by looking around through the viewfinder. A subject often looks different isolated in a viewfinder than it does when you see it surrounded by other objects. What interests you about this scene? What is it that you want to make into a photograph?

Get closer (usually). Often people photograph from too far away. What part of the scene attracted you? Do you want to see the whole deck, or are you more interested in the person cooking? Do you want the whole wall of a building, or was it the graffiti on it that caught your attention?

Kyle Bajakian

Try a different angle. Instead of always shooting from normal eye-level height, try getting up high and looking down on your subject or kneeling and looking up.

Look at the background (and the foreground). How does your subject relate to its surroundings? Do you want the subject centered or off to one side to show more of the setting? Is there a distraction (like bright sunlight or a sign directly behind someone's head) that you could avoid by changing position? Take a look.

More about backgrounds and the image frame on pages 172–175.

Karl Baden

Check the lighting. If this is your first roll, you are most likely to get a good exposure if you photograph a more or less evenly lit scene, not one where the subject is against a very light background, such as a bright sky.

More about lighting on pages 123–139.

Karl Baden

Ray K. Metzker

Experiment, too. Include a bright light or bright sky in the picture (just don't stare directly at the sun through the viewfinder). In the photograph, darker parts of the scene may appear completely black, or the subject itself may be silhouetted against a brighter background.

Getting Started

USING A DIGITAL CAMERA

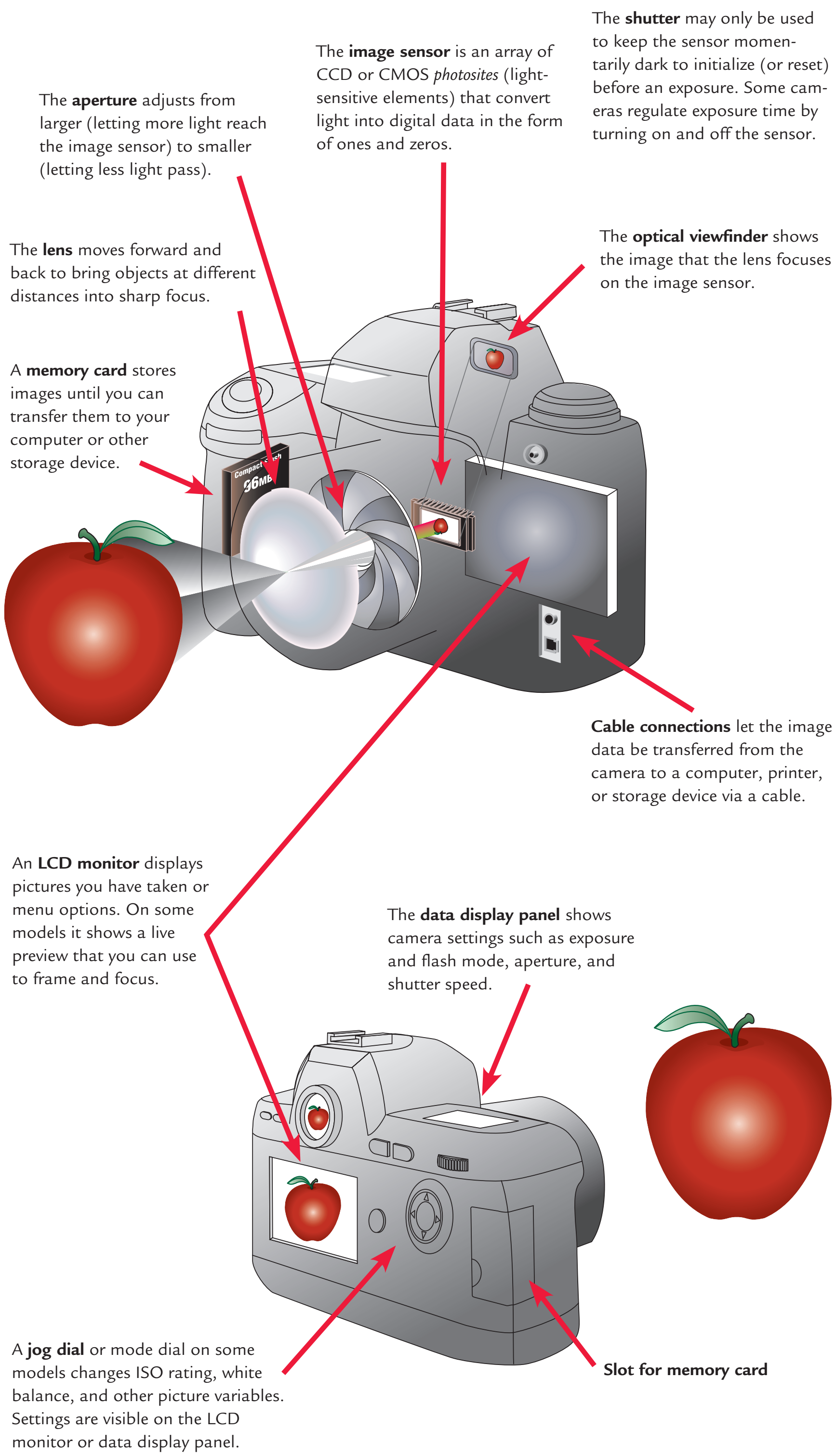
There are some advantages to using a digital camera. You can use the camera's display to see the results of each shot as you make it. You can review any of the pictures stored in its memory to confirm that you have covered an assignment completely and delete undesired photographs to make room for new ones. After you transfer your pictures to a computer or another storage device, you can reuse the same memory card to record more pictures.

Digital cameras let you select the ISO rating (the equivalent of film speed) for each shot. Using a higher ISO can let you shoot in dimmer light, and many digital cameras reach ISOs higher than any film. But just as graininess is more visible with high-speed film, random specks (called noise) occur more often in a digital image as you increase the ISO.

You don't need filters over the lens to correct for color when you use a digital camera. Most cameras adjust each picture's "white balance" for the light source automatically (for example, tungsten or fluorescent) so colors are rendered normally, and the white balance can be further adjusted in the computer after shooting, with a process called editing.

Digital cameras always produce full-color images, but you can easily convert them to black and white—you can set the camera to change them automatically as you shoot or you can do it later, on a computer in the editing step.

Zoom lenses seem to have an increased range with digital zoom, a feature found on some compact digital cameras marketed to amateurs. Digital zoom enlarges a picture electronically, but use it with caution. Optical zoom (see page 36), which physically alters the focal length of the lens to change the image, actually magnifies the scene, but digital zooming only crops the image, enlarging the pixels in the part of the image that's left. The final photograph will not have the quality you'd get by using a longer lens or moving closer for the shot.



Prepare the Camera

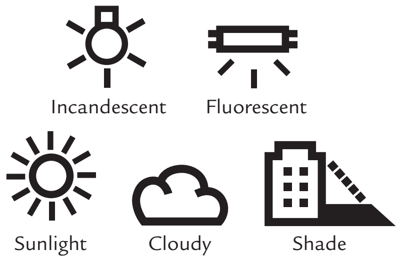
Make sure your camera has fresh batteries. A half-empty symbol will let you know when the battery is low. Carry spares; the camera won't work without batteries.

Insert a memory card only with the camera turned off. Then turn on the camera. Make sure you are using the right kind of card for your camera; cards intended for another camera may not operate correctly in yours.

Select the file type and resolution. These affect the image quality and the number of images your memory card can save. A lower resolution or compressed file lets you store more pictures, but at some loss of quality. Saving pictures in the camera's raw format gives the highest quality.

Select the exposure mode. This camera offers programmed (P), aperture priority (A), shutter priority (S), or manual (M). Your camera might have a dial (above) or a menu on the data display panel. It may let you select autofocus (AF) or manual focus (M) with a separate dial or switch.

Turn on the LCD monitor or view the data display panel. Select an ISO rating (the equivalent of film speed). Lower ratings give better results, but higher ratings, like higher film speeds, may be necessary when shooting in low light. Look through the menu for other important settings.

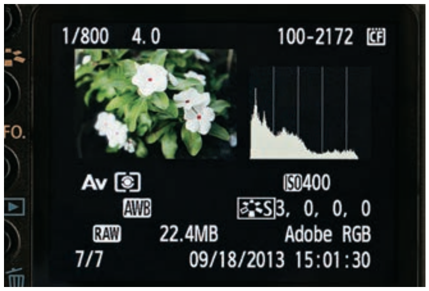


Select the white balance (color temperature) for the dominant light source in which you are shooting, such as incandescent (tungsten) bulbs, sunlight, or outdoor shade. A camera set on automatic makes these adjustments for you. If your camera has a raw format option, it leaves the white balance choice until you edit the file.

Make Some Exposures

Frame your picture by looking at the LCD monitor or through the viewfinder. Focus manually (or press the shutter button halfway down) and check the exposure, as you would with a film camera. Press the shutter button all the way down to take the picture.

Do not turn the power off until the transfer from image sensor to memory card is complete. If you interrupt the power at this point, you could lose your picture, ruin your memory card, or even damage your camera.



You can review all your pictures on the LCD monitor in thumbnail size, along with other recorded information about the exposure. Use the monitor when you need it, but otherwise turn it off to conserve battery power.

Every digital camera is different, although there are many similarities. Read your manual carefully. The steps here are a guide, but the switches, buttons, and menu are often unique to each camera model.

More about memory cards on page 150, exposure modes on page 16, automatic focus on page 39, resolution on page 143, and compression on page 152.

Types of Cameras

What kind of camera is best for you? For occasional snapshots of family and friends, an inexpensive, completely automatic, nonadjustable camera that you just point and shoot—or a cell phone—will probably be satisfactory. But if you have become interested enough in photography to take a class or buy a book, you will want an adjustable camera because it will give you greater creative control. If you buy a camera with automatic features, make sure it is one that allows you to override them manually when you want to make exposure and focus choices yourself.

Single-lens reflex cameras (SLRs) show you a scene directly through the lens, so you can preview what will be recorded. You can see exactly what the lens is focused on; with some cameras, you can check the depth of field (how much of the scene from foreground to background will be sharp). Through-the-lens viewing is a definite advantage with long-focal-length or telephoto lenses, for close-ups, or with any work for which you want a precise view of a scene.

Most SLRs have automatic exposure, automatic focus, and automatic flash, but allow manual control. Many different interchangeable lenses for SLRs are available.

Most digital SLRs (or DSLRs) resemble their 35mm film cousins. Some larger, medium-format film SLR cameras may be used with accessory digital backs. Digital-only models, still called "medium-format," are also available.

SLRs are very popular with professionals such as photojournalists, studio or fashion photographers, or with anyone who wants to move beyond making casual snapshots.

Single-lens Reflex Camera

Compact cameras (sometimes called *point-and-shoot* cameras) are mostly designed for amateur photographers but vary considerably in quality. Some are good enough to be used by professionals when they don't want to carry a larger camera; some are made to be used a few times and thrown away.

Some compact cameras let you see a scene through a peephole, or *viewfinder*, which shows almost—but not quite—the image that will be captured. The viewfinder image is used to select the scene to be photographed, but can't be used for focusing because it doesn't show you which part of the scene will be sharply focused. Most compact cameras focus the image for you.

Because this viewing system is in a different position from the lens that exposes the film, you do not see exactly what the lens sees. This difference between the viewfinder image and the lens image, called *parallax error*, increases as objects come closer to the camera.

Compact digital cameras most often do not have a viewfinder, but show the scene instead in real time on an LCD monitor. This *live view* image is made with the camera's lens, so it can display framing exactly. The disadvantage of an LCD display is that it

Compact Camera

uses more energy from the camera's batteries than any other function.

Full-featured non-DSLR digital cameras, sometimes called *mirrorless* cameras, can give you almost all the control available in a single-lens reflex camera, although many do not offer interchangeable lenses. Some full-featured cameras may fit into the compact size category, some are nearly as large as DSLRs.

A few models, like the one shown on the opposite page, top right, offer the same quality and features as DSLRs but without the moving reflex mirror and penta–prism (see page 17), making them smaller, lighter, and often less expensive.

Rangefinder cameras are viewfinder film cameras with a visual focusing system that you use as you look through the viewfinder window. The window shows a split image when an object is not in focus. As you rotate the focusing ring, the split image comes together when the object is focused sharply. Rangefinder cameras let you focus precisely, even in dim light, but you cannot visually assess the depth of field because, except for the split image, all parts of the scene look equally sharp in the viewfinder.

Better rangefinder cameras correct for parallax and have interchangeable lenses, although usually not in as many focal lengths as are available for

Medium-format Digital SLR

View Camera

SLRs. Most use 35mm film; some (like the one shown below, right) are for wider roll film, few are digital. Rangefinder cameras are fast, reliable, quiet in operation, and relatively small.

View cameras have a lens in the front, a ground-glass viewing screen in the back, and a flexible, accordion-like bellows in between. The camera's most valuable feature is its adjustability: the camera's parts can be moved in relation to each other, which lets you alter perspective and sharpness to suit each scene. You can change lenses and even the camera's back; for example, you can attach a back to use self-developing film or one to record a digital image.

Each film exposure is made on a separate sheet of film, so you can make one exposure in color and the next in black and white, or develop each sheet differently. Film size is large—4 × 5 inches and larger—which makes detail crisp and sharp even in a big print.

View cameras are slower to operate than smaller hand-held cameras. They are also heavier and must be mounted on a tripod. The image on the viewing screen is upside down, and it is usually so dim that you have to put a focusing cloth over your head and the screen to see the image clearly. Use one when you want complete control of an image, such as for architectural or product photography or for personal work, or when you want the highest possible quality.

Rangefinder Film Camera

Twin-lens reflex cameras (TLRs) are now made in very small numbers, but secondhand models are widely available. Almost all have been made for film and are not easily adapted to digital capture. Each camera has two lenses: one for viewing the scene and another just below it that exposes the film.

A large film format (2¼-inches square) is the TLR's advantage. The disadvantages are parallax (because the viewing lens is in a different position from the taking lens) and a viewfinder image that is reversed left to right. A few now-discontinued TLRs had interchangeable lenses; adjustments on all models are completely manual.

Some cameras are made to fill a specialized need.

Underwater cameras are not only for use underwater but for any situation in which a camera is likely to get wet. Some cameras are water resistant, rather than usable underwater. Specially made underwater housings are available for professional camera models.

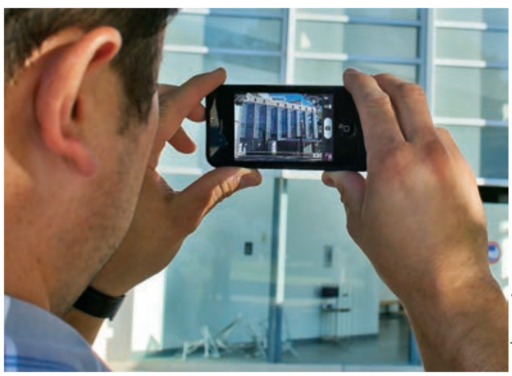
Mirrorless Interchangeable-lens Camera

Panoramic cameras make a long, narrow photograph that can be appropriately used, for example, for landscapes. Some of these cameras crop out part of the normal image rectangle to make a panoramic shape. Others use a wider-than-normal sensor or section of roll film; some may rotate the lens from side to side during the exposure.

Digital panoramas can be made during editing by stitching several individual frames together. Some cameras can merge several frames together in the camera or create a wide image by moving (panning) the camera during one exposure (called a *sweep* mode).

Stereo or 3-D cameras take two pictures at the same time through two side-by-side lenses, the same distance apart as our eyes. The resulting pair of images, a *stereograph*, gives the illusion of three dimensions when seen in a stereo viewer.

Cell phone cameras now outnumber all other picture-making devices by a wide margin, and they capture a majority of the photographs made daily, worldwide. Most take images lower in quality than even an inexpensive compact camera, and few allow the user any control other than where it points and when it shoots, but the best camera is always the one you have with you.



John Upton

Cell Phone Camera

Basic Camera Controls

Get the pictures you want. Cameras don't quite "see" the way the human eye does, so at first the pictures you get may not be the ones you expected. This book will help you gain control over the picture-making process by showing you how to visualize what the camera will capture and how to use the camera's controls to make each picture the one you have in mind. Film cameras are shown here. A digital camera will have some or all of these same controls.

Controls, panels, and dials *appear on both this entry-level single-lens reflex camera (right) and the more sophisticated "system" camera (above) that can be equipped with a wide variety of special-purpose lenses and accessories. Push-buttons and dials let you select the shutter speed (the length of time the shutter remains open) and the aperture (the size of the opening inside the lens). With either camera, you can exchange one lens for another.*

On fully-automatic cameras *like the one above, you press the shutter release and the camera automatically focuses the lens (autofocus) and sets the shutter speed and aperture (autoexposure). When you want to choose camera settings yourself, you can override the automatic functions. Not all fully-automatic cameras give you the option of use in manual mode.*

Focusing. *Through the viewfinder window you see the scene that will be recorded, including the sharpest part of the scene, the part on which the camera is focused. A particular part of a scene can be focused sharply by manually turning the focusing ring on the lens, or you can let an autofocus camera adjust the lens automatically. More about focusing and sharpness appears on pages 38–43.*

Keith Johnson

Shutter-speed control. *Moving objects can be shown crisply sharp, frozen in mid-motion, or blurred either a little bit or a lot. The faster the shutter speed, the sharper the moving object will appear. Turn to pages 18–19 for information about shutter speeds, motion, and blur.*

Aperture control. *Do you want part of the picture sharp and part out of focus or do you want the whole picture sharp from foreground to back-ground? Changing the size of the aperture (the lens opening) is one way to control sharpness. The smaller the aperture, the more of the picture that will be sharp. See pages 20–23.*

Lens focal length. *Your lens's focal length controls the size of objects in a scene and how much of that scene is shown. The longer the focal length, the larger the objects will appear. See pages 28–37 for more about focal length.*

More about Camera Controls

Automatic exposure is a basic feature in almost all 35mm and digital single-lens reflex cameras. The purpose is to let in a controlled amount of light so that the resulting photograph is neither too light nor too dark. The camera's built-in meter measures the brightness of the scene and then sets shutter speed, aperture (lens opening), or both in order to let the right amount of light reach the film or a digital camera's recording sensor. As you become more experienced, you will want to set the exposure manually in certain cases, instead of always relying on the camera. Read more about exposure in Chapter 4, pages 61–75.

You have a choice of exposure modes with many cameras; they should include at least the following four. Read your camera's instruction manual to find out which exposure features your model has and how they work. You may be able to download a replacement manual from the manufacturer's Web site, if you don't have one.

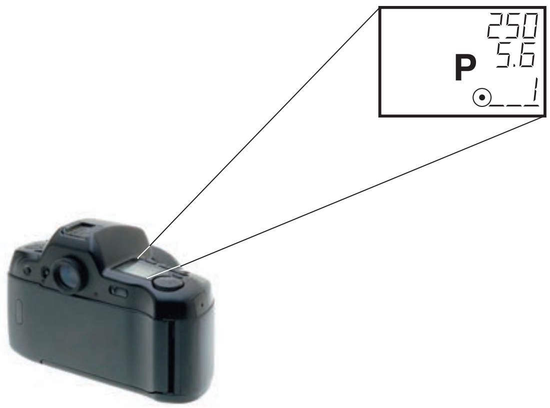
With programmed (fully automatic) exposure, the camera selects both the shutter speed and the aperture based on a program built into the camera by the manufacturer. This automatic operation can be useful in rapidly changing situations because it allows you simply to respond to the subject, focus, and shoot.

In shutter-priority mode, you set the shutter speed and the camera automatically sets the correct aperture. This mode is useful when the motion of subjects is important, as at sporting events, because the shutter speed determines whether moving objects will be sharp or blurred.

In aperture-priority mode, you set the lens opening and the camera automatically sets the shutter speed. This mode is useful when you want to control the depth of field (the sharpness of the image from foreground to background) because the size of the lens opening is a major factor affecting sharpness.

Manual exposure is also a choice with many automatic cameras. You set both the lens opening and shutter speed yourself using, if you wish, the camera's built-in light meter to measure the brightness of the light.

***Exposure information** appears in the viewfinder of many cameras. This viewfinder shows the shutter speed (here, $1/250$ sec.) and aperture (f/5.6). Displays also show you when the flash is ready to fire and give you warnings of under- or overexposure.*

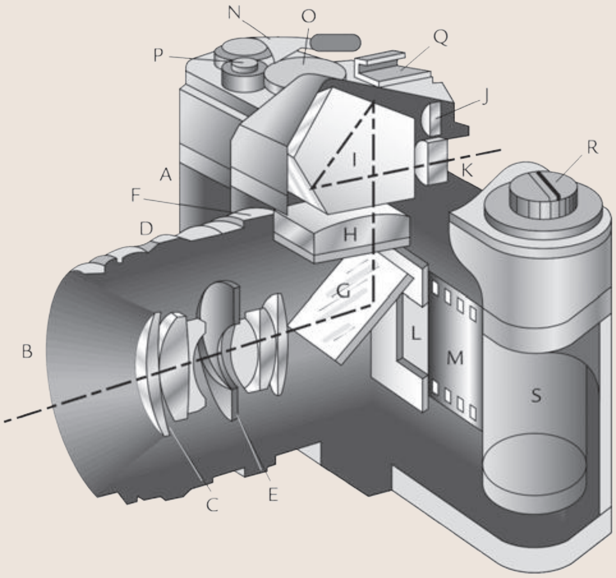


***Some cameras have a data panel** on the body of the camera that shows information such as shutter speed (here, $1/250$ sec.) and aperture (f/5.6). This model also shows the mode of exposure operation (P, for programmed automatic) and the frame number of the film (number 1).*

INSIDE A SINGLE-LENS REFLEX CAMERA

All cameras have the same basic features:

- A light-tight box to hold the camera parts and film or a digital recording sensor
- A viewing system that lets you aim the camera accurately
- A lens to form an image and a mechanism to focus it sharply
- A shutter and lens aperture to control the amount of light that reaches the recording surface
- A means to hold and advance the film or to hold a digital chip and save its captured information



*A **simplified look** inside a single-lens reflex 35mm film camera (designs vary in different models). The camera takes its name from its single lens (another kind of reflex camera has two lenses) and from its reflection of light upward for viewing the image.*

A. **Body.** The light-tight box that contains the camera's mechanisms and protects the film or chip from light until you are ready to make a photograph.

B. **Lens.** Focuses an image in the viewfinder and on the recording surface: film or sensor.

C. **Lens elements.** The optical glass lens components that produce the image.

D. **Focusing ring.** Turning the ring focuses the image by adjusting the distance of the lens from the recording surface. Some cameras focus automatically.

E. **Diaphragm.** A circle of overlapping leaves inside the lens that adjusts the size of the aperture (lens opening). It opens up to increase (or closes down to decrease) the amount of light reaching the recording surface.

F. **Aperture ring or button.** Setting the ring or button determines the size of the diaphragm during exposure.

G. **Mirror.** During viewing, the mirror reflects light from the lens upward onto the viewing screen. During an exposure, the mirror swings out of the way so light can pass straight to the recording surface.

H. **Viewing screen.** A ground-glass (or similar) surface on which the focused image appears.

I. **Pentaprism.** A five-sided optical device that reflects the image from the viewing screen into the viewfinder.

J. **Metering cell.** Measures the brightness of the scene being photographed.

K. **Viewfinder eyepiece.** A window through which the image from the pentaprism is visible.

L. **Shutter.** Keeps light from the recording surface until you are ready to take a picture. Pressing the shutter release opens and closes the shutter to let a measured amount of light reach the film or chip.

M. **Film.** A light-sensitive material that records the image. The ISO, or film speed (the rating of a particular film's sensitivity), is set into the camera by turning a dial or, on some cameras, is set automatically when you load the film. Digital cameras record images on an image sensor (a CCD or CMOS chip) in the same location.

N. **Film advance.** A lever that advances the film to the next unexposed segment. More recent and more expensive cameras advance film automatically; those and digital cameras have no lever.

O. **Shutter-speed dial or button.** Selects the shutter speed, the length of time the shutter remains open. On some models, it also sets the mode of automatic exposure operation.

P. **Shutter release.** A button that activates the exposure sequence in which the aperture adjusts, the mirror rises, the shutter opens, and light strikes the recording surface.

Q. **Hot shoe.** A bracket that attaches a flash unit to the camera and provides an electrical linking that synchronizes camera and flash.

R. **Rewind mechanism.** On manual cameras, a crank you turn to rewind film into its cassette after a roll of film has been exposed. Cameras with a motor to advance the film (N) also rewind it automatically.

S. **Film cassette.** The light-tight container in which 35mm film is packaged. Digital cameras use a memory card to store images.

Shutter Speed

AFFECTS LIGHT AND MOTION

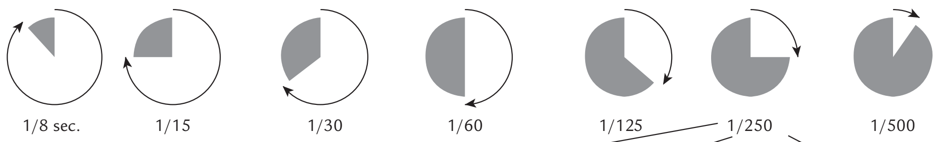
Light and the shutter speed. To make a correct exposure, so that your picture is neither too light nor too dark, you need to control the amount of light that reaches the digital image sensor (or film). The shutter speed (the amount of time the shutter remains open) is one of two controls your camera has over the amount of light. The aperture size (page 20) is the other. In automatic operation, the camera sets the shutter speed, aperture, or both. In manual operation, you choose both settings. The shutter-speed dial (a push button on some cameras) sets the shutter so that it opens for a given fraction of a second after the shutter release has been pressed. The B (or bulb) setting keeps the shutter open as long as the shutter release is held down.

Motion and the shutter speed. In addition to controlling the amount of light that enters the camera, the shutter speed also affects the way that moving objects are shown. A fast shutter speed can freeze motion—1/250 sec. is more than fast enough for most scenes. A very slow shutter speed will record even a slow-moving object with some blur. The important factor is how much the image actually moves across the recording surface. The more of that surface it crosses while the shutter is open, the more the image will be blurred, so the shutter speed needed to freeze motion depends in part on the direction in which the subject is moving in relation to the camera (see opposite page).

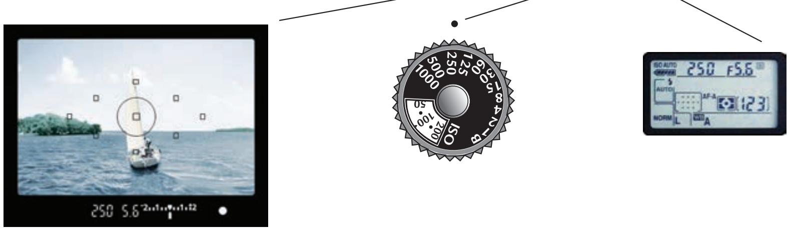
The lens focal length and the distance of the subject from the camera also affect the size of the image on the sensor (or film) and thus how much it will blur. A subject will be enlarged if it is photographed with a long-focal-length lens or if it is close to the camera; it has to move only a little before its image crosses enough of the recording surface to be blurred.

Obviously, the speed of the motion is also important: all other things being equal, a darting swallow needs a faster shutter speed than does a hovering hawk. Even a fast-moving subject, however, may have a peak in its movement, when the motion slows just before it reverses. A gymnast at the height of a jump, for instance, or a motorcycle negotiating a sharp curve is moving slower than at other times and so can be sharply photographed at a relatively slow shutter speed.

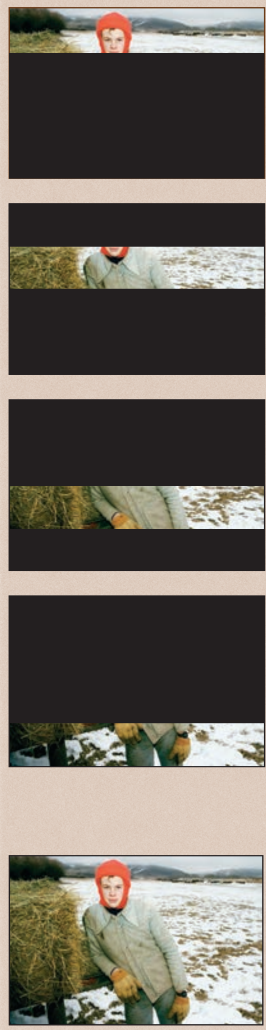
See the project on motion, page 179.



Shutter speeds appear in the camera's viewfinder (near right), on the shutter-speed dial (center), or as data panel readout (far right). Here, the camera is set to 1/250 sec. Notice that only the bottom number of the fraction is shown on the camera.



***Shutter-speed settings** are in seconds or fractions of a second: 1 sec., 1/2 sec., 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, and sometimes 1/2000, 1/4000, and 1/8000. Each setting lets in twice as much light as the next faster setting, half as much as the next slower setting: 1/250 sec. lets in twice as much light as 1/500 sec., half as much as 1/125 sec. With many cameras, especially in automatic operation, shutter speeds are "stepless"; the camera can set the shutter to 1/225 sec., 1/200 sec., or whatever speed it calculates will produce a correct exposure.*



Drex Brooks

***A focal-plane shutter** consists of a pair of curtains usually located in the camera body just in front of the sensor. During exposure, the curtains open to form a slit that moves across the light-sensitive surface.*

The size of the slit is adjustable: the wider the slit, the longer the exposure time and the more light that reaches the sensor or film. Focal-plane shutters are found in most single-lens reflex cameras and some rangefinder cameras.

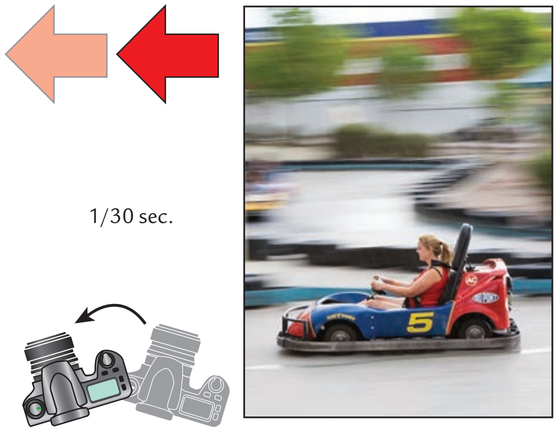
A leaf shutter *is usually built into the lens instead of the camera body. The shutter consists of overlapping leaves that open during the exposure, then close again.*

The longer the shutter stays open, the more light reaches the light-sensitive surface. Leaf shutters are found on most compact, point-and-shoot, rangefinder, and twin-lens reflex cameras, view-camera lenses, and some medium-format single-lens reflex cameras.

Slow shutter speed, subject blurred. *The direction a subject is moving in relation to the camera can affect the sharpness of the picture. At a slow shutter speed, a driver moving from right to left is not sharp.*

Fast shutter speed, subject sharp. *Photographed at a faster shutter speed, the same driver moving in the same direction is sharp. During the shorter exposure, her image did not cross enough of the recording surface to blur.*

Slow shutter speed, subject sharp. *Here the driver is sharp even though photographed at the slow shutter speed that recorded blur in the first picture. She was moving directly toward the camera, so her image did not cross enough of the recording surface to blur. The other go-kart, turning to move across the frame, becomes blurred.*



Panning *with the vehicle is another way to keep it and the driver relatively sharp. During the exposure, the photographer moved the camera in the same direction that the go-kart was moving. Notice the streaky look of the background, characteristic of a panned shot.*

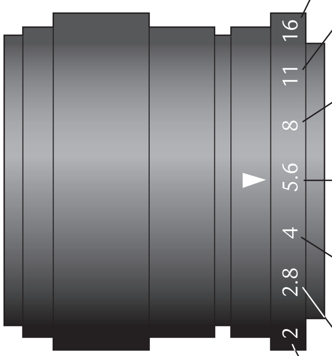
Blurring to show motion. Freezing motion is one way of representing it, but it is not the only way. In fact, freezing motion sometimes eliminates altogether the feeling of movement so that the subject seems to be at rest. Allowing the subject to blur can be a graphic means of showing that it is moving.

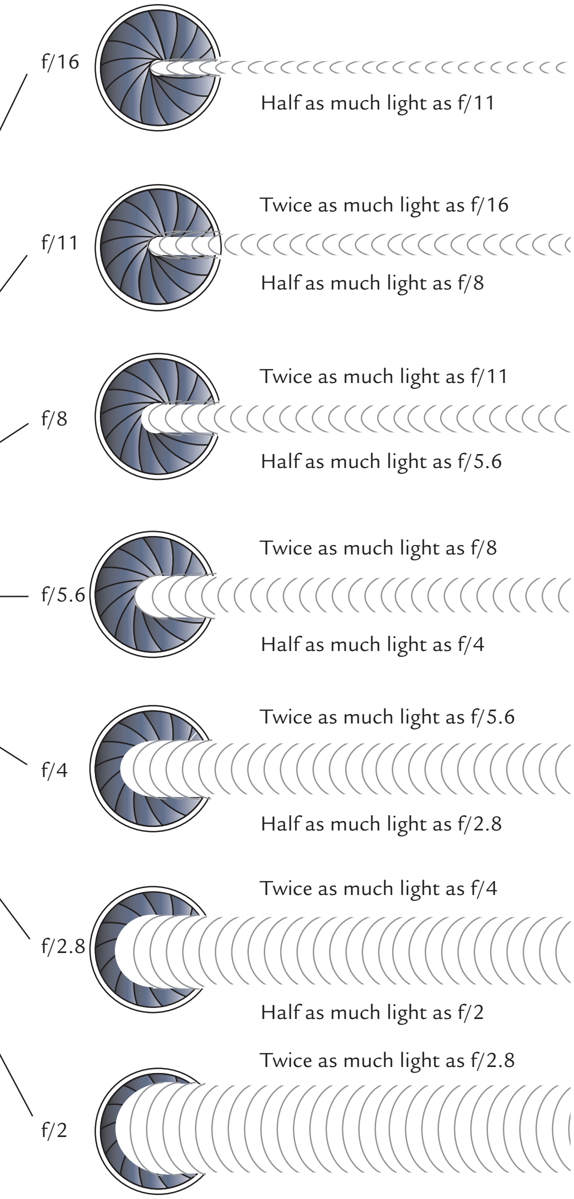
Panning to show motion. Panning the camera—moving it in the same direction as the subject's movement during the exposure—is another way of showing motion (bottom right). The background will be blurred, but the subject will be sharper than it would be if the camera were held steady.

Aperture

AFFECTS LIGHT AND DEPTH OF FIELD

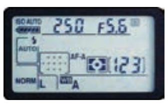
Light and the aperture. The aperture, or lens opening, is the other control that you can use in addition to shutter speed to adjust the amount of light that reaches the film or digital image sensor. Turning a ring on the outside of the lens (pushing a button on some cameras) changes the size of the *diaphragm*, a ring of overlapping metal leaves inside the lens. (In automatic operation, the camera can do this for you.) Like the iris of your eye, the diaphragm can get larger (open up) to let more light in; it can get smaller (stop down) to decrease the amount of light.





Light and the aperture. *The size of the lens opening—the aperture, or f-stop—controls the amount of light that passes through the lens. Each aperture is one "stop" from the next; that is, each lets in twice as much light as the next smaller opening, half as much light as the next larger opening. Notice that the lower the f-stop number, the wider the lens opening and the more light that is let in. For example, f/8 is a wider opening and lets in more light than f/11, which lets in more light than does f/16, and so on.*

Aperture settings appear on a camera's lens aperture ring (shown above), in the viewfinder (below left), or as data-panel readout (below right). Here, the camera is set to f/5.6.



Aperture settings (f-stops). Aperture settings, from larger lens openings to smaller ones, are f/1, f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, f/11, f/16, f/22, and f/32. Settings beyond f/32 are usually found only on some view-camera lenses.

The lower the f-stop number, the wider the lens opening; each setting lets in twice as much light as the next f-stop number up the scale, half as much light as the next number down the scale. For example, f/11 lets in double the light of f/16, half as much as f/8. Larger openings have smaller numbers because the f/ number is a ratio: the focal length of the lens divided by the diameter of the lens opening.

Referring to a *stop* is a shorthand way of stating this half-or-double relationship. You can give one stop more (twice as much) exposure by setting the aperture to its next wider opening, one stop less (half as much) exposure by *stopping* (closing) down the aperture to its next smaller opening.

No lens has the entire range of f-stops; most have about seven. A 50mm lens may range from f/2 at its widest opening to f/16 at its smallest, a 200mm lens may range from f/4 to f/22. Most lenses can set intermediate f-stops partway between the whole stops, often in one-third-stop increments. The widest lens setting may be an intermediate stop, for example, f/1.8.

Depth of field and the aperture. The size of the aperture setting also affects how much of the image will be sharp. This is known as the depth of field. As the aperture opening gets smaller, the depth of field increases and more of the scene from near to far appears sharp in the photograph (see photos, below, and pages 40 and 43). See the depth of field project on page 177.

Small Aperture
More Depth of Field

Depth of field and the aperture. *The smaller the aperture opening, the greater the depth of field. At f/16 (left, top), with the hands and string in the foreground crisply in focus, the face in the background is also sharp. At a much larger aperture, f/1.4 (left, bottom), there is very little depth of field. The face in the background is completely out of focus.*

Large Aperture
Less Depth of Field

Shutter Speed and Aperture

BLUR VS. DEPTH OF FIELD

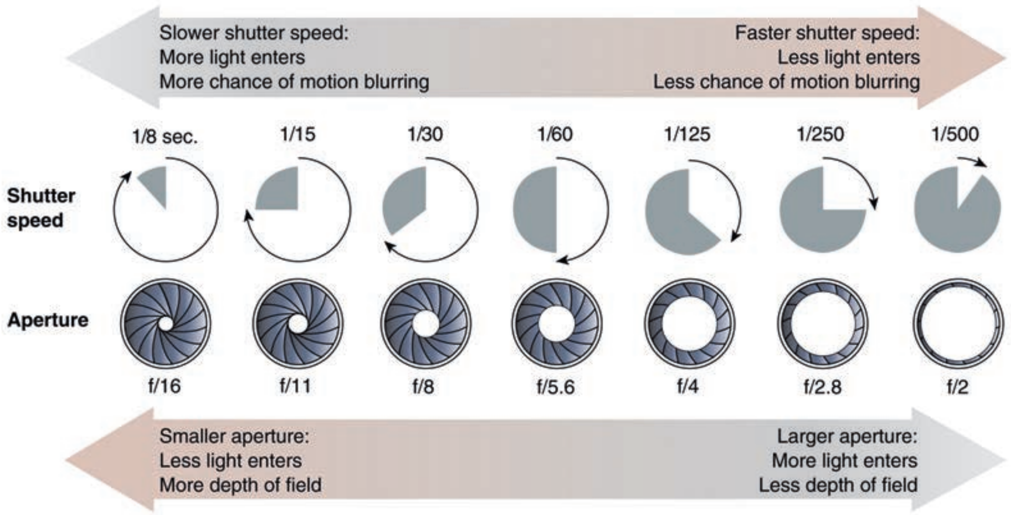
Controlling the exposure. Both shutter speed and aperture affect the amount of light reaching the camera's recording surface. To get a correctly exposed picture, one that is neither too light nor too dark, you need to find a combination of shutter speed and aperture that will let in the right amount of light for a particular scene and film or digital ISO setting. (Pages 61–75 explain how to do this.)

Equivalent exposures. Once you know a correct combination of shutter speed and aperture, you can change one setting and still keep the exposure the same as long as you change the other setting the same amount in the opposite direction. If you want to use a smaller aperture (which lets in less light), you can keep the exposure the same by using a slower shutter speed (which lets in more light), and vice versa.

A stop of exposure change. Each full f-stop setting of the aperture lets in half (or double) the amount of light as the next full setting, a one-stop difference. Each shutter-speed setting does the same. The term stop is used whether the aperture or shutter speed is changed. The exposure stays constant if, for example, a move to the next faster shutter speed (one stop less exposure) is matched by a move to the next larger aperture (one stop more exposure). This back-and-forth relationship between aperture and shutter speed is called *reciprocity*.

Which combination do you choose? Any of several combinations of shutter speed and aperture could make a good exposure, but the effect on the appearance of the image will be different. Shutter speed affects the sharpness of moving objects; aperture size affects depth of field (the sharpness of a scene from near to far). Shutter speed also helps prevent blur caused by camera motion during the exposure. If you are holding the camera in your hands, you need a faster shutter speed than if you have the camera on a tripod (see page 24 for details).

You can decide for each picture whether stopped motion or depth of field is more important. More depth of field and near-to-far sharpness with a smaller aperture means you would be using a slower shutter speed and so risking that motion would blur. Using a faster shutter speed to freeze motion means you would be using a larger aperture, with less of the scene sharp near to far. Depending on the situation, you may have to compromise on a moderate amount of depth of field with some possibility of blur.

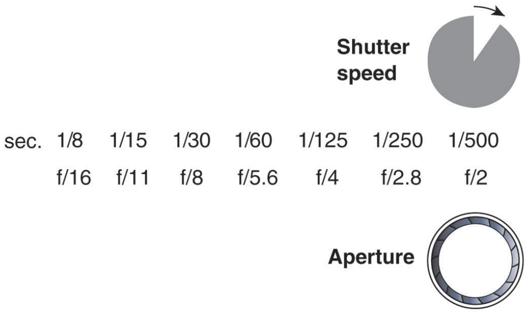


Shutter speed and aperture combinations. *Both the shutter speed and the aperture size control the amount of light. Each setting lets in half (or double) the amount of light as the adjacent setting—a one-stop difference.*

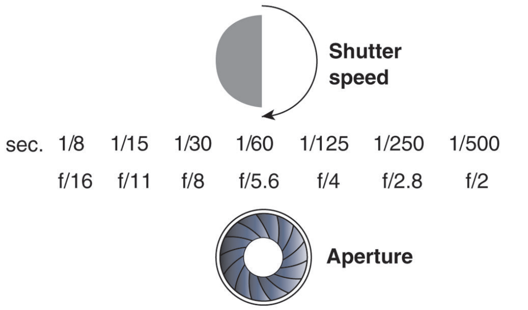
If you decrease the amount of light one stop by moving to the next smaller aperture setting, you can keep the exposure constant by also moving to the next slower shutter speed. In automatic operation, the camera makes these changes for you.

Each combination of aperture and shutter speed shown at left lets in the same amount of light; but see the photographs on the opposite page: the combinations change the sharpness of the picture in different ways.

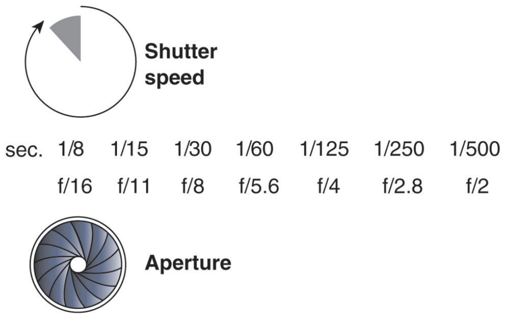
Fast shutter speed *(1/500 sec.): the moving swing is sharp.* ***Wide aperture*** *(f/2): the trees, picnic table, and person in the background are out of focus. Only objects the same distance as the foreground posts, on which the lens was focused, are sharp.*



Medium-fast shutter speed *(1/60 sec.): the moving swing shows some blur.* ***Medium-wide aperture*** *(f/5.6): the background is still a little fuzzy but the middle ground appears in focus.*



Slow shutter speed *(1/8 sec.): the moving swing is completely blurred.* ***Small aperture*** *(f/16): the middle and background are completely sharp, but the slow shutter speed required the use of a tripod.*



This image was intentionally removed for this version.

Shutter speed and aperture combinations. *Each of the exposure combinations for this scene lets in the same total amount of light, so the overall exposure stays the same. But the motion of the swing is blurred with a slow shutter speed, sharp with a fast shutter speed. The depth of field (overall sharpness of near-to-far objects) is shallow with a larger aperture, extends farther with a small aperture.*

Getting the Most from Your Camera and Lens

Camera motion causes blur. Though some photographers claim to be able to hand hold a camera steady at slow shutter speeds—1⁄15 sec. or even slower—it takes only a slight amount of camera motion during exposure to cause a noticeable blur in an image. If a sharp picture is your aim, using a fast shutter speed or supporting the camera on a tripod is a much surer way to produce a sharp image.

When hand holding the camera (see right, top and center), use the focal length of your lens as a guide to how fast your shutter speed should be. The longer the focal length, the faster the shutter speed must be, because a long lens magnifies any motion of the lens during the exposure just as it magnifies the size of the objects photographed.

As a general rule, the slowest shutter speed that is safe to hand hold is matched to the focal length of the lens. That is, a 50mm lens should be hand held at a shutter speed of 1⁄50 sec. or faster, a 100mm lens at 1⁄100 sec. or faster, and so on. This doesn't mean that the camera can be freely moved during the exposure. At these speeds, the camera can be hand held, but with care. At the moment of exposure, hold your breath and squeeze the shutter release smoothly.

The camera itself can affect your ability to hand hold it; some cameras vibrate more than others during exposure. A single-lens reflex camera, with its moving mirror, for example, vibrates more than a rangefinder or compact camera. Some newer (and more expensive) lenses have electronic stabilization systems that help you take sharp photographs at longer exposures.

A tripod and cable release (shown right, bottom) will keep the camera absolutely still during an exposure. The tripod supports the camera steadily; the cable release lets you trigger the shutter without having to touch the camera directly. A tripod and cable release are useful when you need a slower shutter speed than is feasible for hand holding, for example, at dusk when the light is dim. They also help when you want to compose a picture carefully or do close-up work. They are always used for copy work, such as photographing a painting, another photograph, or something from a book, because hand-holding at even a fast shutter speed will not produce critical sharpness for fine details. A view camera is always used on a tripod.

The job of a cable release, to trigger the shutter without transmitting movement, may also be accomplished at a distance with a variety of remote wireless triggers that use radio or infrared signals.

To protect a camera in use, use a neck strap, either worn around your neck or wound around your wrist. It keeps the camera handy and makes you less likely to drop it. Lenses can be kept in lens cases or plastic bags to protect them from dust, with lens caps both back and front for additional protection of lens surfaces.

A padded bag, case, or backpack will protect your equipment from bumps and jolts when it is carried or moved, a camera bag makes your accessories and extra film readily available. Aluminum or molded plastic cases with fitted foam compartments provide the best protection; some are even waterproof. Their disadvantage is that they are bulky, not conveniently carried on a shoulder strap, and the camera may not be rapidly accessible.

Battery power is essential to the functioning of most cameras. If your viewfinder display or other data display begins to act erratically, the batteries may be getting weak. Many cameras have a battery check that will let you test battery strength or an indicator that warns of low power. It's a good idea to check batteries before beginning a day's shooting or a vacation outing and to carry spares in your camera bag. If you don't have spares and the batteries fail, try cleaning the ends of the batteries and the battery contacts in the camera with a pencil eraser or cloth; the problem may just be poor electrical contact. Warming the batteries in the palm of your hand might also bring them back to life temporarily.

To hand hold a camera, *keep feet apart, rest the camera lightly against your face. Hold your breath as you squeeze the shutter release slowly.*

With the camera in a vertical position, *the left hand holds and focuses the lens; the right hand releases the shutter.*

A tripod and cable release *are essential if you want a sharp image at slow shutter speeds. Keep some slack in the cable release so it doesn't tug the camera.*

Clean inside the camera. *When you blow or dust inside the camera, tip the camera so the dust falls out and isn't pushed into the mechanism. Don't touch the shutter curtain unless absolutely necessary.*

Clean the lens. *First, blow or brush any visible dust off the lens surface. Hold the lens upside down to let the dust fall off the surface instead of just circulating on it.*

Use lens cleaning fluid. *Dampen a wadded piece of lens-cleaning tissue with the fluid and gently wipe the lens with a circular motion. Don't put lens fluid directly on the lens because it can run to the edge and soak into the barrel. Finish with a gentle, circular wipe using a dry lens tissue.*

Cameras and film in transit should be protected from excessive heat; for example, avoid leaving them in a car on a sunny day. Excessive heat not only damages the quality of film, it can also soften the oil lubricant in the camera, causing the oil to run out and create problems, such as jamming lens diaphragm blades. At very low temperatures, batteries and other mechanisms may be sluggish, so on a cold day it is a good idea to keep the camera warm by carrying it under your coat until you're ready to take a picture. To keep condensation off the lens when you bring a camera in from the cold, let it warm up before removing the lens cap. On the beach, protection from salt spray and sand is vital.

If a camera will not be used for a while, turn off any on/off switches, and store the camera away from excessive heat, humidity, and dust. For long-term storage, remove batteries because they can corrode and leak. With a film camera, press the shutter-release button so that the shutter is not left cocked; operate the shutter occasionally because it can become balky if not used.

Protect your camera from dust and dirt. Load and unload film or change lenses in a dust-free place if you possibly can. If changing film, blow or brush around the camera's film-winding mechanism and along the film path. This will remove dust as well as tiny bits of film that can break off and work into the camera's mechanisms. Be careful of the shutter curtain when doing this; it is delicate and should be touched only with extreme care. You may want to blow occasional dust off the focusing mirror or screen, but a competent camera technician should do any work beyond this. Dust and specks that appear in your viewfinder are usually outside the optical path and will likely not appear in your photographs.

Use the right equipment for the job: to blow, a rubber squeeze bulb; to brush, a clean, soft brush designed for photo use. A can of compressed gas produces more force than a rubber squeeze bulb. If you use compressed gas, make sure the product you use does not contain ozone-damaging chlorofluorocarbon (CFC). Never lubricate any part of the camera or lens yourself.

If you have a digital camera, follow the general guidelines above for camera body, lens, and battery care. Be especially careful, however, to protect the camera against shock, heat, and sudden temperature changes, and keep it away from strong magnetic fields.

Any lens surface must be clean for best performance, but keeping dirt off it in the first place is much better than frequent cleaning, which can damage the delicate lens coating. Particularly avoid touching the lens surface with your fingers because they leave oily prints that etch into the coating. Keep a lens cap on the front of the lens when it is not in use and add one on the back of the lens if the lens is removed from the camera. During use, a lens hood helps protect the lens surface in addition to shielding the lens from stray light that may degrade the image. UV (ultraviolet) and 1A filters are designed for use with color film but have virtually no effect on black-and-white film, so some photographers leave one on the lens all the time for protection against dirt and accidental damage.

To clean the lens you will need a rubber squeeze bulb or a can of compressed gas, a soft brush, lens tissue, and lens cleaning fluid. Use compressed gas to remove dust, lens cleaner if you have fingerprints or smears. Cans of compressed gas may spray propellant if tilted; keep them vertical for use. Avoid using cleaning products made for eyeglasses, particularly any treated cloths; they are too harsh for lens surfaces. A clean cotton cloth or paper tissue is usable in an emergency, but lens tissue or untreated microfiber is much better.

Geoffrey Robinson
Press photographers outside Buckingham Palace on the royal wedding day of Prince William and Kate Middleton, London, 2011.
Working photographers are often constrained to a prearranged location at major events. *Robinson shows us why it is difficult to report the news with an unusual point of view.*

Lens  2

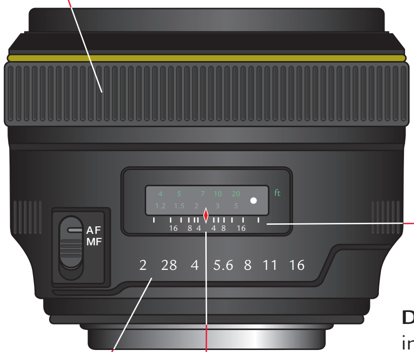
Forming an image. Although a good lens is essential for making crisp, sharp photographs, you don't actually need one to take pictures. A primitive camera can be constructed from little more than a shoe box with a tiny pinhole at one end and a digital sensor, a piece of film, or a sheet of light-sensitive photographic paper at the other. A pinhole won't make as clear a picture as a glass lens, but it does form an image of objects in front of it.

A simple lens, such as a magnifying glass, will form an image that is brighter and sharper than an image formed by a pinhole. But a simple lens has many optical defects (called *aberrations*) that prevent it from forming an image that is sharp and accurate. A modern compound lens subdues these aberrations by combining several simple lens elements made of different kinds of glass and ground to different thicknesses and curvatures so that they cancel out each other's aberrations.

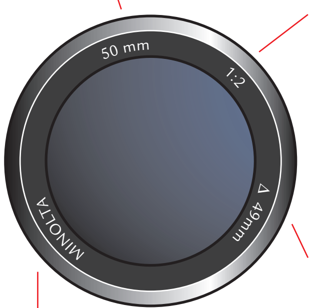
The main function of a lens is to project a sharp, undistorted image onto the light-sensitive surface. Lenses vary in design, and different types perform some jobs better than others. Two major differences in lens characteristics are focal length and speed.

Lens focal length is, for a photographer, the most important characteristic of a lens. One of the primary advantages of a single-lens reflex camera or a view camera is the interchangeability of its lenses; many photographers own more than one lens so they can change lens focal length. More about focal length appears on the following pages.

Lens speed is not the same as shutter speed. More correctly called *maximum aperture*, it is the widest aperture to which the lens diaphragm can be opened. A lens that is "faster" than another opens to a wider aperture and admits more light; it can be used in dimmer light or with a faster shutter speed.



On the lens barrel *(as shown above) are controls such as a ring that focuses the lens. Cameras and lenses vary in design, so check the features of your own camera. For example, many cameras have push-button or dial controls on the camera body instead of an aperture control ring on the lens. Markings on the lens (shown below) always include its focal length and maximum aperture (or a range for each if it is a zoom), usually along with a serial number and the maker's name.*



Lens Focal Length

A BASIC DIFFERENCE BETWEEN LENSES

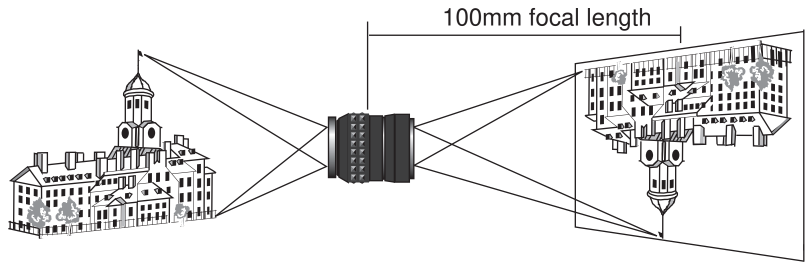
Photographers describe lenses in terms of their focal length; generally they refer to a normal, long, or short lens, a 50mm lens, a 24–105mm zoom lens, and so on. Focal length affects the image formed on the film or sensor in two important and related ways: the amount of the scene shown (the angle of view) and thus the size of objects (their magnification). A lens with a single, or fixed, focal length is called a *prime* lens; a variable or adjustable focal-length lens is called a *zoom* lens.

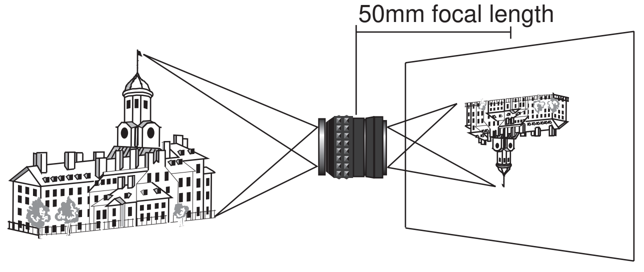
How focal length affects an image. The shorter the focal length of a lens, the more of a scene the lens takes in and the smaller it makes each object in the scene appear in the image. You can demonstrate this by looking through a circle formed by your thumb and forefinger. The shorter the distance between your hand (the lens) and your eye (the film or digital sensor), the more of the scene you will see (the wider the angle of view). The more objects that are shown on the same size negative or sensor, the smaller all of them will have to be (the less magnification). Similarly, you could fill a negative or sensor either with an image of one person's head or with a group of twenty people. In the group portrait, each person's head must be smaller.

Interchangeable lenses are convenient, as are zoom lenses (see page 36). The amount of a scene shown and the size of objects can be changed by moving the camera closer to or farther from the subject, but the option of changing lens focal length gives you much more flexibility and control. Sometimes you can't easily get closer to your subject—for example, standing on shore photographing a boat on a lake. Sometimes you can't get far enough away, as when you are photographing a large group of people in a small room.

With a camera that accepts different lenses, such as a single-lens reflex camera, you can remove one lens and put on another when you want to change focal length. Interchangeable lenses range from super-wide-angle fisheye lenses to extra-long telephotos.

Digital cameras often have smaller sensors, which affects the angle of view. A sensor the size of a 35mm film frame is called full frame. With any lens, a smaller sensor will record a smaller rectangle than a full frame, like cropping a movie screen in a theater, and will see a narrower angle of view. Lens focal lengths for cameras with small sensors are often stated as a "35mm equivalent," giving the focal length of a lens that—on a full frame camera—would have the same angle of view.





Focal length *is measured from an optical point near the back of a lens to the image it forms on the film or digital image sensor. It is measured when the lens is sharply focused on an object in the far distance (technically known as infinity). Magnification, the size of an object in an image, is directly related to focal length. As the focal length increases, the imaged size of the object increases. A 100mm lens produces an image twice as large as one produced by a 50mm lens.*

Project:

LENS FOCAL LENGTH

YOU WILL NEED

A camera either with a zoom lens or with lenses of two different focal lengths. The greater the difference in focal lengths, the easier it will be to see the difference between them. If you can, use a short-focal-length lens (35mm or shorter) and a long lens (85mm or longer).

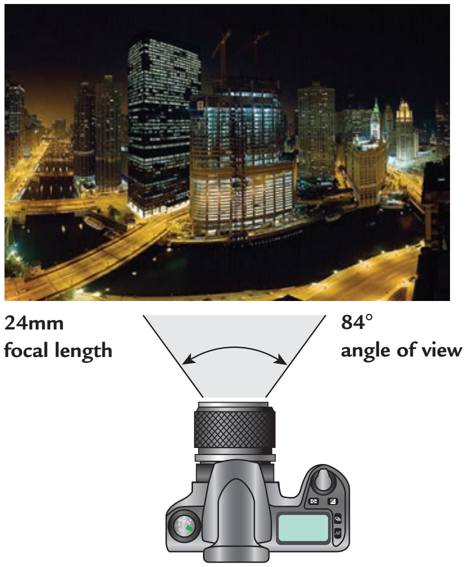
PROCEDURE

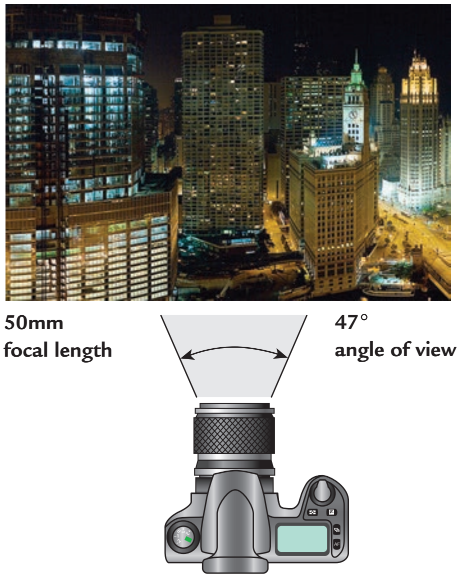
Put the shorter lens on the camera or adjust the zoom lens to its shortest focal length (its widest view). Make a head-to-toe photograph of a friend. Note the distance you have to stand from your subject to have his or her feet just touch the bottom edge of the viewfinder frame while the top of the head grazes its upper edge.

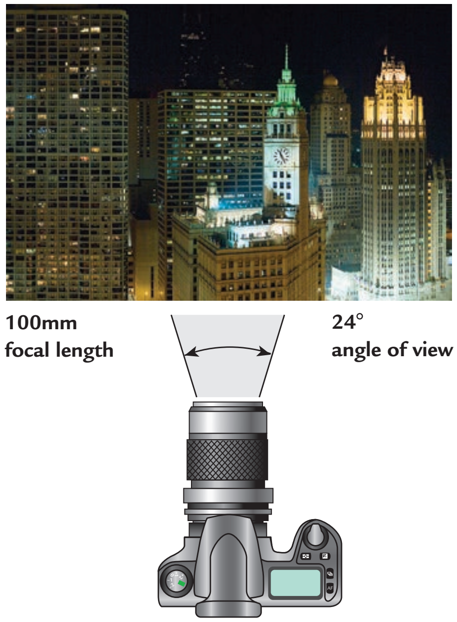
Do the same with the longer lens or with the zoom lens adjusted to its longest focal length (its narrowest view). Make a similar pair of views of a house or a chair, fitting your subject exactly into the frame on the film.

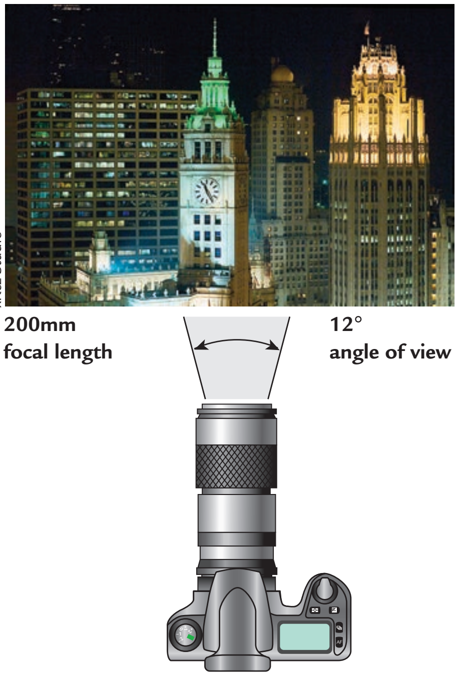
HOW DID YOU DO?

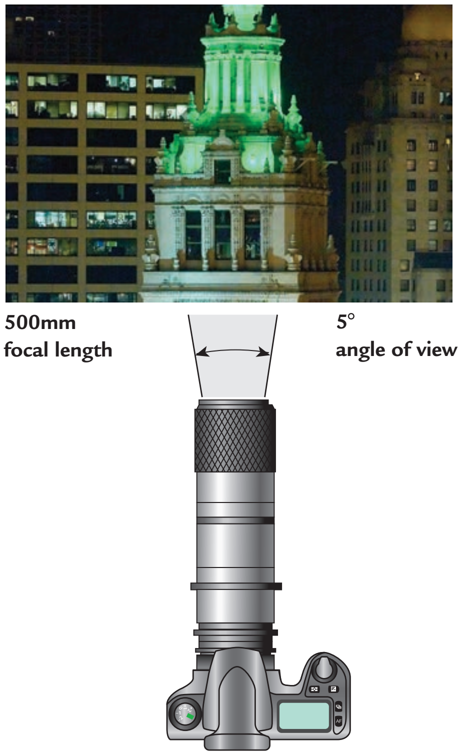
Compare the pairs of views. How did the distances you had to be from your subject with the short lens compare to those needed with the long lens? How do the backgrounds in the pairs of views differ? Did the impression of depth in the photographs change when you switched from the short to the long lens? What else changed?

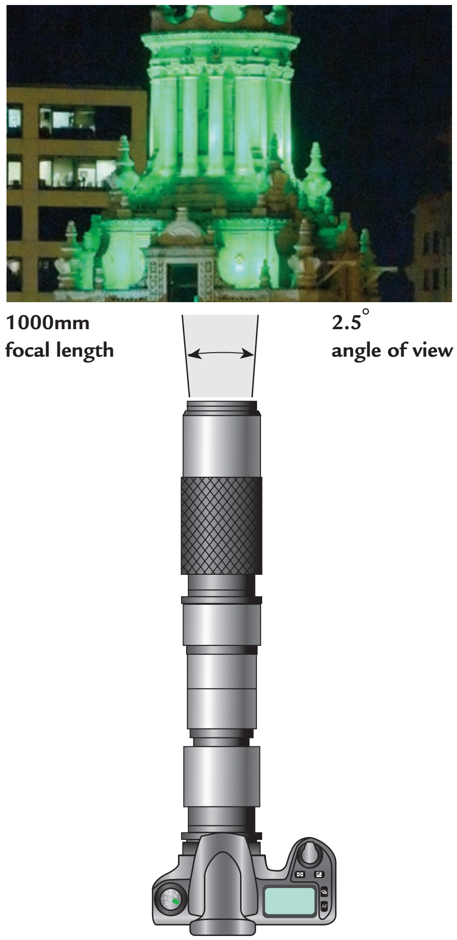












xRez Studio

What happens when you change lens focal length? *If everything else stays the same, changing the focal length of the lens changes both the amount of a scene included in the image (angle of view) and the size of objects (magnification). To make this sequence, the photographer changed only the focal length of the lenses; the distance from lens to subject remained the same. As the focal length increases (for example, from 24mm to 50mm), the angle of view narrows and the size of objects increases.*

These illustrations are accurate for comparing angles of view on a full-frame digital or 35mm film camera or when using "35mm equivalent" focal lengths.

Normal Focal Length

THE MOST LIKE HUMAN VISION

A **lens of normal focal length,** as you might expect from the name, produces an image on film that seems normal when compared with human vision. The image includes about the same angle of view as the human eye sees clearly when looking straight ahead, and the relative size and spacing of near and far objects appear normal. For 35mm film cameras (or full-frame digital), this effect is produced by a lens of about 50mm focal length; 35mm single-lens reflex cameras typically are fitted by manufacturers with lenses of that length.

The size of the film (or sensor) used in a particular camera determines what focal length is normal for it. As a rough guide, the focal length of a normal lens is approximately equal to the diagonal across the image frame. Cameras that use film sizes larger than 35mm have proportionately longer focal lengths for their normal lenses. Normal focal length for a film format of 2¼ × 2¾ inches (6 × 7 cm) is 80mm. Normal focal length for a view camera with 4 × 5-inch film is 150mm. Most digital sensors are smaller than a 35mm frame so their normal lens are shorter than one for a 35mm camera or for a full-frame digital sensor. See the chart at the bottom of page 41.

Normal lenses have many advantages. Compared with lenses of much shorter or much longer focal length, normal lenses are generally faster; they can be designed with wider maximum apertures that admit more light. Therefore, they are convenient for use in dim light, especially

Alison Carey. *Graze, 2009.* ***A normal-focal-length lens*** *is a useful all-purpose lens in the studio. Carey fabricates her imagined landscapes indoors on a small scale with clay and paint. Carefully controlled artificial light and a painted backdrop help mimic reality. Her normal-focal-length lens provides a comfortable working distance and opens to a wide aperture when she wants shallow depth of field.*

where action is involved, as in theater or indoor sports scenes or in low light levels outdoors. They are a good choice if the camera is to be hand held because a wide maximum aperture permits a shutter speed fast enough to prevent blur caused by camera movement during exposure. Generally, the normal lens is more compact and lighter, as well as somewhat less expensive, than lenses of much longer or much shorter focal lengths.

Choice of focal length is a matter of personal preference. Many photographers with 35mm or full-frame cameras regularly use a 35mm focal-length lens rather than 50mm because they like the wider view and greater depth of field it has compared to a 50mm lens. Some photographers use an 85mm lens because they prefer its narrower view, which can concentrate the image on the central objects of interest in the scene.

Henri Cartier-Bresson. *Greece, 1961.* ***A lens of normal focal length*** *produces an image that appears similar to that of normal human vision. Cartier-Bresson made many of his best-known photographs with a 50mm lens on his 35mm Leica camera. The amount of the scene included in the image and the relative size and placement of near and far objects are what you would expect to see if you were standing next to the camera. The scene does not appear exaggerated in depth, as it might with a short-focal-length lens, nor do the objects seem compressed and too close together, as sometimes happens with a long-focal-length lens.*

Long Focal Length

TELEPHOTO LENSES

A prime lens of long focal length seems to bring things closer, just as a telescope does. As the focal length gets longer, less of the scene is shown (the angle of view narrows), and what is shown is enlarged (the magnification increases). This is useful when you are so far from the subject that a lens of normal focal length produces an image that is too small. Sometimes you can't get really close—at a sports event, for example. Sometimes it is better to stay at a distance, as in nature photography. An Olympic finish line, the president descending from Air Force One, and an erupting volcano are all possible subjects for which you might want a long lens.

How long is a long lens? A popular medium-long lens for a 35mm or full-frame digital camera is 105mm; this focal length magnifies your view significantly but not so much that the lens's usefulness is limited to special situations. A lens of 65mm has a comparably long focal length for a digital camera with a 1.6× lens conversion factor (see page 35), so does a 300mm lens on a 4 × 5 view camera. The difference between a medium-long lens and an extremely long one (for example, a 500mm lens with a 35mm camera) is rather like that between a pair of binoculars and a high-power telescope. You may want a telescope occasionally, but usually binoculars will do.

A long lens provides relatively little depth of field. When you use long lenses, you'll notice that as the focal length increases, depth of field decreases so that less of the scene is in focus at any given f-stop. For example, when focused at the same distance, a 200mm lens at f/8 has less

Ed Jones. *Fishermen's Dragon Boat Race, Hong Kong, 2010.* ***A long lens can seem to compress space.*** *Forced to shoot from shore, Jones chose a 500mm lens to fill his frame with the action. The boats and oarsmen seem to be stacked on top of one another in a jumble of action and color. When do you get this effect and why? See pages 44–45 to find out.*

Andreas Feininger. *The Ocean Liner* Queen Mary, *New York City, 1946.*
A long lens magnifies a distant subject, *letting you shoot from a distance. Feininger used a 1000mm lens to shoot across the Hudson River from the New Jersey shore, two miles away. Built as a luxury liner, the* Queen Mary *served through World War II as a troop transport beginning in 1940, and was decommissioned shortly after this photograph was taken.*

depth of field than a 100mm lens at f/8. This can be inconvenient—for example, if you want objects to be sharp both in the foreground of a scene and in the background. But it can also work to your advantage by permitting you to minimize unimportant details or a busy background by having them out of focus.

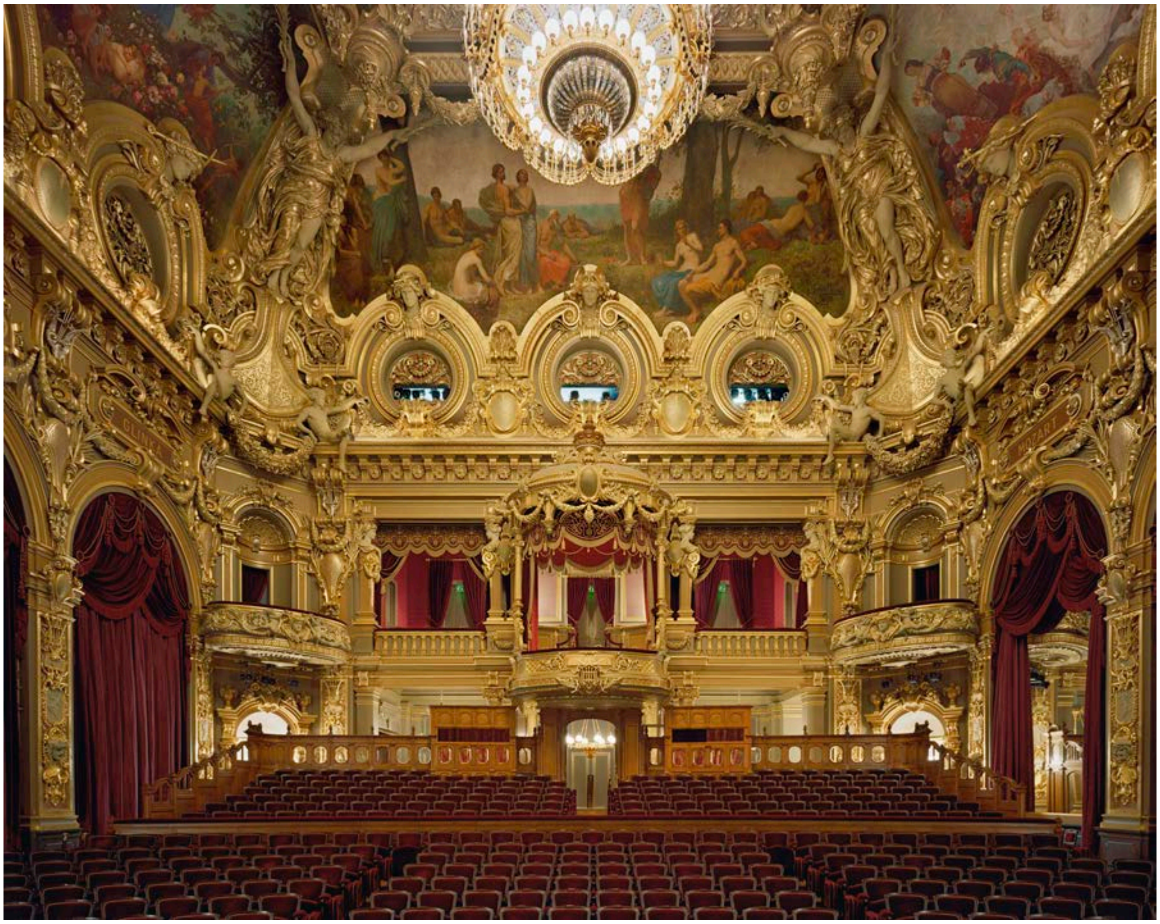
A medium-long lens is useful for portraits because the photographer can be relatively far from the subject and still fill the image frame. Many people feel more at ease when photographed if the camera is not too close. Also, a moderate distance between camera and subject prevents the exaggerated size of facial features closest to the camera that occurs when a lens is very close. A good working distance for a head-and-shoulders portrait is 6–8 ft. (2–2.5 m), easy to do with a medium-long lens—from 85 to 135mm focal length.

A long prime lens, compared with one of normal focal length, is larger, heavier, and somewhat more expensive. Its largest aperture is relatively small; f/4 or f/5.6 is common. It must be focused carefully because with its shallow depth of field there will be a distinct difference between objects that are sharply focused and those that are not. A faster shutter speed is needed to keep the image sharp while hand holding the camera (or a tripod should be used for support) because the enlarged image magnifies the effect of even a slight movement of the lens during exposure. These disadvantages increase as the focal length increases, but so do the long lens's unique image-forming characteristics.

Photographers often call any long lens a telephoto lens, or tele, although not all long-focal-length lenses are actually of telephoto design. The optics of a true telephoto make it smaller than a conventional lens of the same focal length. A tele-extender or teleconverter contains an optical element that increases the effective focal length of a lens. It attaches between the lens and the camera. The optical performance, however, will not be as good as the equivalent long lens.

Short Focal Length

WIDE-ANGLE LENSES



David Leventi. *Opéra de Monte-Carlo, Monaco, 2009.* ***A shorter-focal-length lens lets you show a more complete view of the scene from any viewpoint.*** *For his book* Opera, *Leventi photographed the world's great opera houses—this one opened in 1879—all from the central vantage point of a solo performer. Using a wide lens he could gather, from his fixed location, nearly the entire ornate interior.*

Wide-angle lenses are also popular with photojournalists, feature photographers, and others who shoot in fast-moving and sometimes crowded situations. For example, many photojournalists regularly use 35mm or 28mm as their "normal" lens instead of a 50mm lens. These medium-short lenses give a wider angle of view than does a 50mm lens, which makes it easier to include the setting in close quarters. Shorter lenses also give you more depth of field, which can let a photographer focus the lens approximately instead of having to fine-focus every shot.

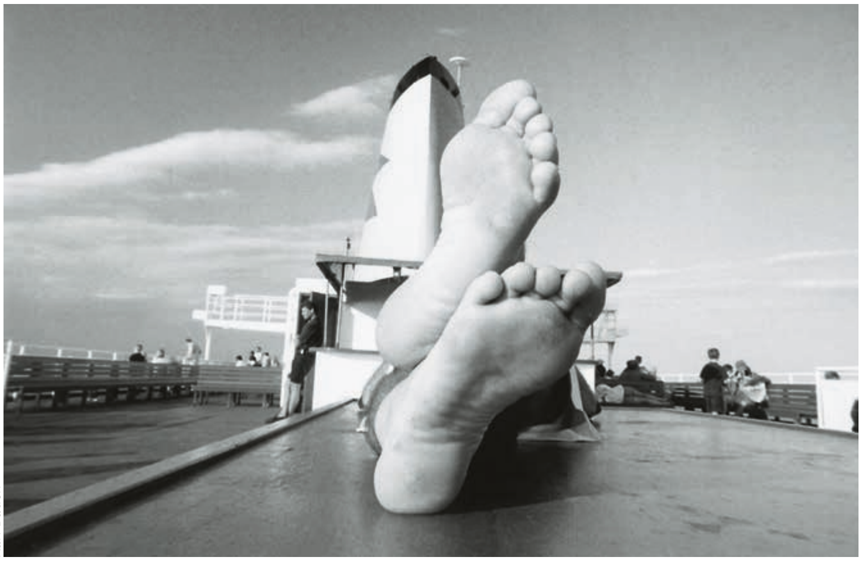
Lenses of short focal length are also called wide-angle or sometimes wide-field lenses, which describes their most important feature—they view a wider angle of a scene than normal. A lens of normal focal length records what you see when you look at a scene with eyes fixed in one position. A 35mm wide-angle lens records the 63° angle of view that you see if you move your eyes slightly from side to side. A 7.5mm fisheye lens records the 180° angle you see if you turn your whole head to look over your left shoulder and then over your right shoulder.

A popular short focal length for a 35mm camera is 28mm. Comparable focal lengths are 55mm for a camera with 6 × 7 cm format, and 90mm for a 4 × 5-inch view camera.

A short lens can give great depth of field. The shorter the focal length of a lens, the more of a scene will be sharp (if the f-stop and distance from the subject remain unchanged). A 28mm lens, for example, when stopped down to f/11 can produce an image that is sharp from less than 4 ft. (1.2 m) to infinity (as far as the eye or lens can see), which often will eliminate the need for further focusing as long as the subject is within the range of distances that will be sharp.

Some digital camera lenses give you unexpected depth of field. The focal length of a lens called normal—or wide or long—depends on the size or format of the film or digital sensor you are using. A 150mm lens is a long lens on a 35mm camera (or a digital camera with a 24 × 36mm sensor), normal on a 4 × 5 view camera, and wide angle on an 8 × 10 view camera. The light-sensitive recording chip in many digital cameras is smaller than the 24 × 36mm frame of

Short lenses show a wide view. *Short-focal-length lenses are useful for including a wide view of an area. They are capable of great depth of field so that objects both close to the lens and far from it will be in focus, even at a relatively large aperture.*



Karl Baden

Objects up close appear larger. *A short lens can produce strange perspective effects. Because it can be focused at very close range, it can make objects in the foreground large in relation to those in the background. With the lens close to the resting man's feet, they look monumental, making a photograph with an entirely different meaning than the one above.*

a 35mm camera. If it is, its normal lens will be shorter than the 50mm lens that is normal for 35mm film.

Digital camera makers often describe lenses with a "35mm-equivalent" if a camera's sensor is smaller than full-frame. Alternately, some manufacturers give a *lens conversion* or *crop* factor; multiply the actual focal length of the lens by this factor to get the 35mm equivalent. The digital camera pictured on page 13 top right, for example, has a crop factor of 1.5, so its 35mm prime lens will capture almost exactly the same view as a 50mm normal lens on a 35mm camera. The compact camera at the top of page 12 has a fixed zoom lens (see page 36) with a focal length of 4.3–86mm. Because of the small sensor size, its 35mm equivalent is a 24–480mm zoom.

But that is only a comparison of angle-of-view. Depth of field, on the other hand, depends on the actual focal length of the lens; if everything else stays the same, a shorter lens will always give you greater depth of field. Using the digital camera and zoom lens mentioned above, you would get much greater depth of field for any photograph than you would using its 35mm-equivalent lens and a 35mm film camera.

Wide-angle "distortion." A wide-angle lens can seem to distort an image and produce strange perspective effects. Sometimes these effects are actually caused by the lens, as with a fisheye lens (page 37 bottom). But, more often, what seems to be distortion in an image made with a wide-angle lens is caused by the photographer shooting very close to the subject.

A 28mm lens, for example, will focus as close as 1 ft. (0.3 m), and shorter lenses even closer. Any object seen from close up appears larger than an object of the same size that is at a distance. While you are at a scene, your brain knows whether you are very close to an object, and ordinarily you would not notice any visual exaggeration. In a photograph, however, you notice size comparisons immediately. Our impression of perspective is based on size relationships that depend on lens-to-subject distance. See the photographs at left.

Zoom, Macro, and Fisheye Lenses

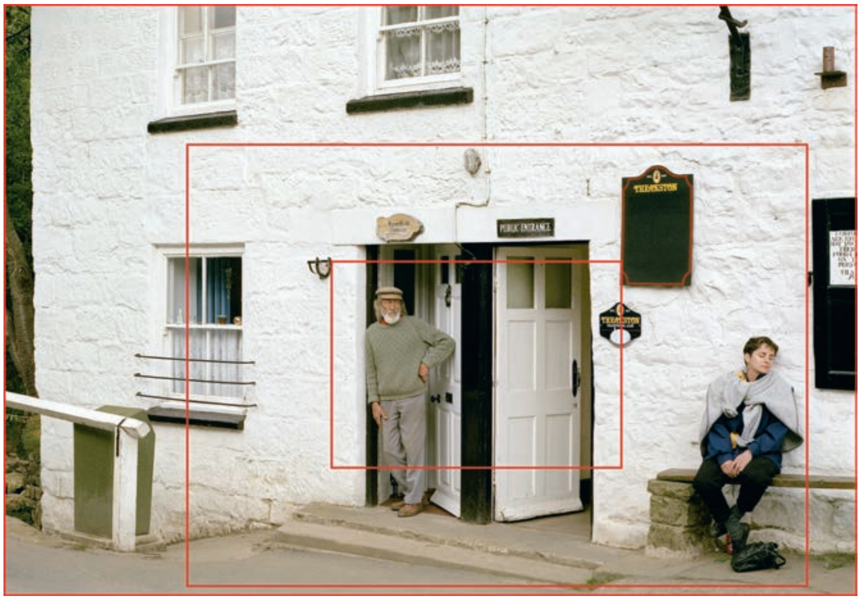
Other lenses can view a scene in a new way or solve certain problems with ease. Those described here are in addition to the usual range of short-, long-, and normal-focal-length lenses.

Zoom lenses are popular because they combine a range of focal lengths into one lens (see below). The glass elements of the lens can be moved in relation to each other; thus infinitely variable focal lengths are available within the limits of the zooming range. Using a 50–135mm zoom, for example, is like having a 50mm, 85mm, and 135mm lens instantly available, plus any focal length in between. Compared to prime, or fixed-focal-length, lenses, zooms are somewhat more expensive, bulkier, and heavier, but one of them will replace two or more fixed-focal-length lenses. Zoom lenses are best used where light is ample because they have a relatively small maximum aperture. Older zoom lenses were significantly less sharp than fixed-focal-length lenses but new designs nearly match them. The "kit" lenses sold as a package with DSLRs are usually zooms. Most current zoom lenses are also autofocus.

Macro lenses are used for close-up photography (opposite, top). Their optical design corrects for some lens aberrations that cause problems at very short focusing distances, but they can also be used at normal distances. Their disadvantages are a slightly smaller maximum aperture, often f/2.8 for a 50mm lens, and slightly higher cost. (More about making close-up photographs on pages 46–47.)

Macro-zoom lenses combine both macro and zoom features. They focus relatively close, although usually not as close as a fixed-focal-length macro lens, and give a range of focal length choices in one lens.

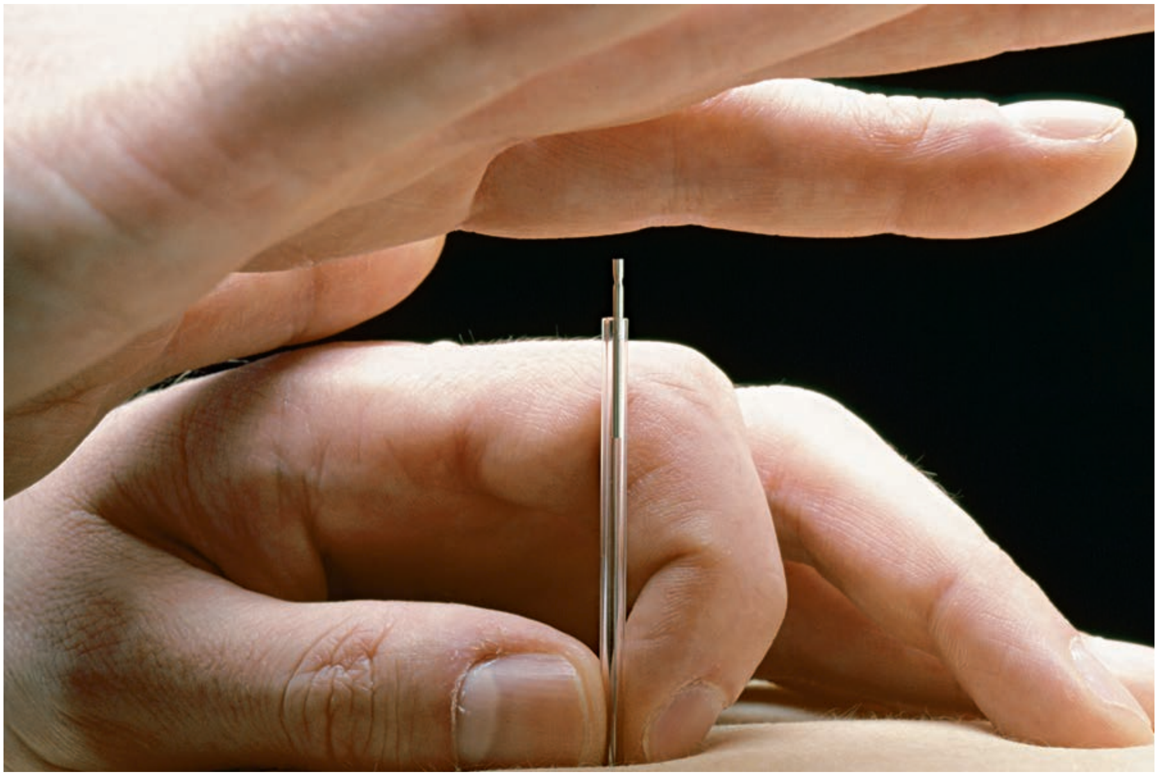
Fisheye lenses have a very wide angle of view—up to 180°—and they exaggerate to an extreme degree differences in size between objects that are close to the camera and those that are farther away. They actually distort the image by bending straight lines at the edges of the picture (opposite, bottom). Fisheye lenses also produce a great deal of depth of field: objects within inches of the lens and those in the far distance will be sharp.



Robert Richfield

***A zoom lens** gives you a choice of different focal lengths within the same lens. The rectangles overlaid on the picture show you some of the very different ways you could have made this photograph by zooming in to shoot at a long focal length or zooming back to shoot at a shorter one.*

Stanley Rowin. *Acupuncture, 1995.* ***The therapist's hands were shot with a macro lens.*** *The background was purposefully rendered dark and featureless to avoid distracting from the subject.*



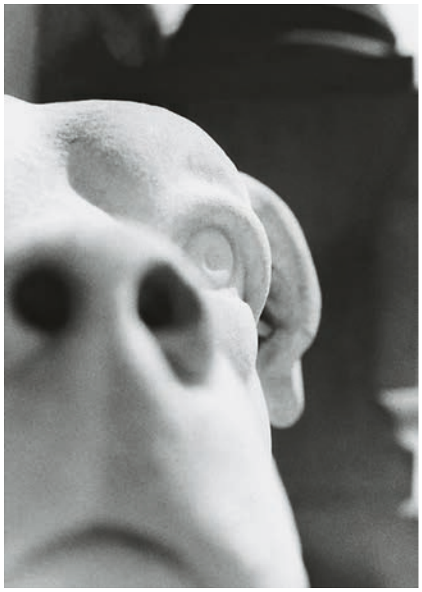
Donald Miralle. *Woodlake Rodeo, California, 2005.* ***A fisheye lens*** *and unusual vantage point help capture the fury of a bull breaking from the gate at the start of a bull-riding competition. The fence is bent into a curve by the lens. Objects at the edge of the fisheye's image circle are distorted more than those at the center.*

Focus and Depth of Field

Sharp focus attracts the eye. Sharp focus acts as a signal to pay attention to a particular part of a photograph, especially if other parts of the image are not as sharp. If part of a picture is sharp and part is out of focus, it is natural to look first at the sharply focused area (see photographs, page 177). When you are photographing, it is also natural to focus the camera sharply on the most important area. You can select and, to a certain extent, control which parts of a scene will be sharp.

When you focus a camera on an object, the distance between lens and film (or digital image sensor) is adjusted, automatically with an internal motor or manually by your rotating a ring on the lens barrel, until the object appears sharp on the viewing screen. You focus manually by turning that focusing ring until the object appears sharp in your viewfinder or a mark on the lens barrel corresponding to its distance aligns with a focusing mark. If you are using an automatic-focus camera, you focus by aiming the focus indicator in your viewfinder (usually a spot in the center) at the object and partially depressing the shutter-release button. The motor in the lens moves the lens elements away from or closer to the film or sensor until that spot is in focus.

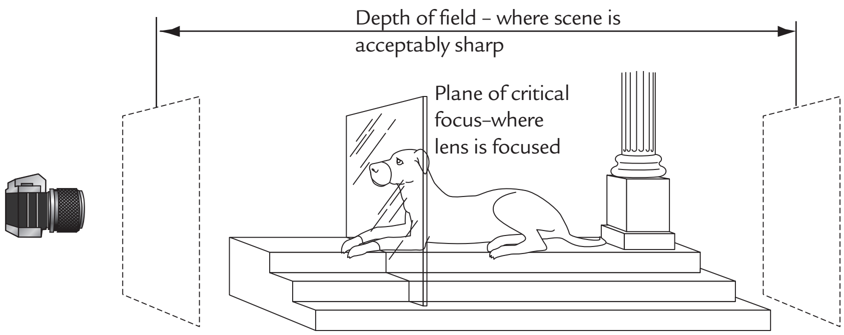
Depth of field. In theory, a lens can only focus on a flat plane at one single distance at a time and objects at all other distances will be less sharp. The distance from your lens to that plane, the *plane of critical focus*, is called the *object distance* and is usually indicated by a distance scale on the lens. In most cases, however, part of the scene will be acceptably sharp both in front of and behind the most sharply focused plane. Objects will gradually become more and more out of focus the farther they are from the most sharply focused area. This region within which objects appear acceptably sharp in the image—the depth of field—can be increased or decreased (see pages 40–41).



Karl Baden

Depth of field is the part of a scene that appears acceptably sharp in a photograph. *Depth of field can be deep, with everything sharp from near to far. In the photograph above, left, it extends from the dog's paws in the foreground to the fluted column behind him. The photographer actually focused on the dog's eye.*

For another picture, above right, the photographer wanted shallow depth of field, with only some of the scene sharp. Here the only sharp part of the picture is the eye on which the lens was focused.



Imagine the plane of critical focus *(the distance on which you focus the lens) to be something like a pane of glass stretched from one side of the scene to the other. Objects that lie along that plane will be sharp. In front of and behind the plane of critical focus lies the depth of field, the area that will appear acceptably sharp. The farther objects are from the plane of critical focus in a particular photograph, either toward the camera or away from it, the less sharp they will be. If objects are far enough from the plane of critical focus to be outside the depth of field, they will appear noticeably out of focus.*

Notice that the depth of field extends about one-third in front of the plane of critical focus, two-thirds behind it. This is true at normal focusing distances, but, when focusing very close to a subject, the depth of field is more evenly divided, about half in front and half behind the plane of critical focus.

Automatic Focus

Automatic **focus** used to be found only on point-and-shoot snapshot cameras. But now it is standard equipment on almost all cameras. When you push down the shutter-release button part way, the camera adjusts the lens to focus sharply on what it thinks is your subject—usually whatever object is at the center of the viewing screen.

Sometimes you will want to focus the camera manually. Just as with automatic exposure, there will be times when you will want to override the automatic mechanism and focus the camera yourself. Most single-lens reflex cameras with automatic focus will also let you focus manually.

Automatic focus can mean out of focus *when a scene has a main subject (or subjects) off to one side and at a different distance from whatever object is at the center. Most autofocus cameras will focus on the object at the center of the frame, here within the small bracketed area.*

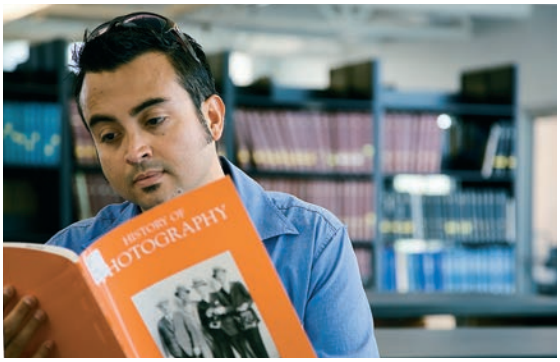
The most common problem occurs when your subject is at the side of the frame, not at the center (see photos, left). A camera may also have problems focusing through glass, or if a subject has very low contrast, is in very dim light, or consists of a repetitive pattern.

Moving subjects can also cause problems. The adjustment of the autofocus mechanism can sometimes take long enough for a fast-moving subject, such as a race car, to move out of range. The lens may "hunt" back and forth, unable to focus at all or may make an exposure with the subject out of focus.

Some cameras have more sophisticated electronics to deal with these problems better. Automatic focus is more rapid, for example, when the focusing motor is located in the lens instead of the camera body. Some cameras can be set so the lens, once it is focused on a moving object, will keep it in focus for a series of exposures. Read the instructions for your camera and lens so you know how the autofocus mechanism operates.

To correct this, *first choose the focusing distance by placing the autofocus brackets on the main subject and partially pressing down the shutter-release button. Lock the focus by keeping partial pressure on the shutter release.*

Take a moment to evaluate each situation. Override the automatic system when it is better to do so, rather than assume that the right part of the picture will be sharp simply because you are set for automatic focus.



Reframe your picture *while keeping partial pressure on the shutter release. Push the shutter button all the way down to make the exposure.*

Depth of Field

CONTROLLING SHARPNESS IN A PHOTOGRAPH

Depth of field. Completely sharp from foreground to background, totally out of focus except for a shallow zone, or sharp to any extent in between—you get to choose how much of your image will be sharp. When you make a picture, you can manipulate three factors that affect the depth of field (the distance in a scene between the nearest and farthest points that appear sharp in a photograph). Notice in the illustrations opposite that doing so may change the image in other ways.

Aperture size. Stopping down the lens to a smaller aperture, for example, from f/2 to f/16, increases the depth of field. As the aperture gets smaller, more of the scene will be sharp in the photograph.

Focal length. Using a shorter-focal-length lens also increases the depth of field at any given aperture. For example, more of a scene will be sharp when photographed with a 50mm lens at f/8 than with a 200mm lens at f/8.

Lens-to-subject distance. Moving farther away from the subject increases the depth of field most of all, particularly if you started out very close to the subject.

Marc PoKempner. *Rev. Ike, Chicago, 1975.* ***Shallow depth of field lets you draw immediate attention to one area;*** *we tend to look first at the sharpest objects in a photograph. The message of preacher Reverend Ike is that God is generous and will give you exactly what you ask for, including, for example, a diamond-studded watch, ring, and cuff links, on which the photographer focused.*

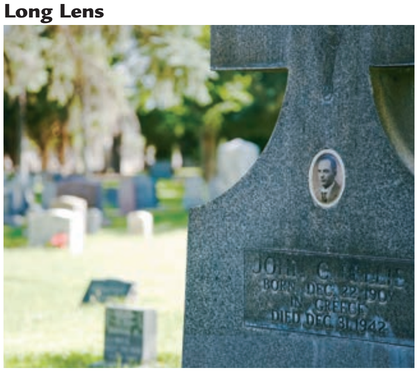
The smaller the aperture (with a given lens), the greater the depth of field. *Using a smaller aperture for the picture on the far right increased the depth of field and made the image much sharper overall. With the smaller aperture, the amount of light entering the camera decreased, so a slower shutter speed had to be used to keep the total exposure the same.*

Large Aperture

Small Aperture

The shorter the focal length of the lens, the greater the depth of field. *Both of these photographs were taken from the same position and at the same aperture. Notice that changing to a shorter focal length for the picture on the far right not only increased the depth of field but also changed the angle of view (the amount of the scene shown) and the magnification of objects in the scene.*

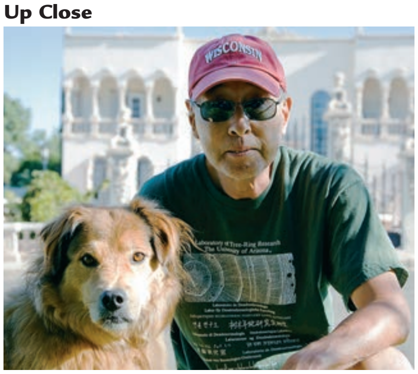
Long Lens



Short Lens

The farther you are from a subject, the greater the depth of field, *at any given focal length and aperture. The photographer stepped back to take the picture on the far right. If you focus on an object far enough away, the lens will form a sharp image of all objects from that point out to infinity.*

Up Close



Farther Back

Small Sensor = Great Depth of Field

Digital cameras with small sensors can give you unexpected depth of field. The shorter a lens's focal length (at the same aperture and distance from the subject), the greater the depth of field. The size of a camera's sensor affects what is considered a normal-, short-, or long-focal-length lens for that camera.

A "normal" lens for a camera (see page 30) is one with a focal length about the same as the length of a diagonal line across the light-sensitive surface in the camera. A full-frame digital or 35mm film camera has a 24 × 36mm light-sensitive surface: a normal lens for that camera is 50mm.

The sensor in most digital cameras is smaller—in many cases, considerably smaller. A normal lens for that type of camera will be shorter than the 50mm lens that is normal for a full-frame camera, and so will have more depth of field. The compact digital camera pictured on page 12, top, for example, has a sensor of 6.2 × 4.55mm. The normal focal length is 8mm. If everything else is equal, the 8mm lens will give you much greater depth of field than the 50mm lens.

Small sensors use an obscure naming system *devised for TV camera tubes in the 1950s. Here are sensor diagonals—hence normal lens lengths—for some common sizes.*

Sensor Name	Diagonal
1/2″	8.0mm
1/1.8″	8.9mm
2/3″	11.0mm
4/3″	22.5mm
1.8″ (APS-C)	28.4mm

More about Depth of Field

HOW TO PREVIEW IT

Know the extent of the depth of field when photographing a scene—how much of the scene from near to far will be sharp—to make better pictures. You may want to be sure that certain objects are sharp. Or you may want something deliberately out of focus, such as a distracting background. To control what is sharp, it is useful to have some way of gauging the depth of field.

Checking the depth of field. With a single-lens reflex camera, you view the scene through the lens. No matter what aperture setting you have selected, the lens is ordinarily wide open for viewing to make the viewfinder image as bright and easy to see as possible. However, the large aperture size means that you see the scene with depth of field at its shallowest. When you press the shutter release, the lens automatically closes down to the taking aperture. Unless you are taking a picture using the widest aperture, the viewfinder image will not have the same depth of field as the final photograph. Some single-lens reflex cameras have a previewing mechanism that lets you, if you wish, stop down the lens to view the scene at the taking aperture and see how much will be sharp.

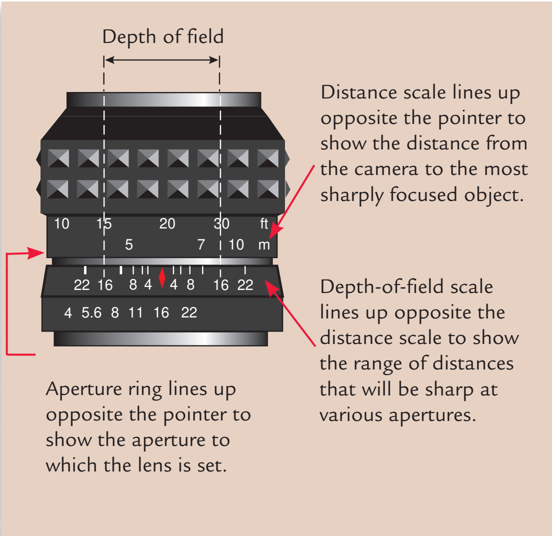
Unfortunately, if the lens is set to a very small aperture, the stopped-down image on the viewing screen may be too dark to be seen clearly. If so, or if your camera doesn't have a preview feature, you may be able to read the near and far limits of good focus on a depth-of-field scale on the lens barrel (this page, bottom). Many newer autofocus lenses don't have them, but you can use tables showing the depth of field for different lenses at various focusing distances and f-stops. Such tables were originally printed in books, now online and port–able calculators and smartphones provide the same information (see opposite page).

A rangefinder or viewfinder camera shows you the scene through a small window in the camera body through which all objects look equally sharp. Some digital cameras without a viewfinder window let you zoom in to a test shot on the monitor to judge depth of field very accurately. You can also use a depth-of-field scale on the lens barrel, a printed table, or a calculator to estimate depth of field with these cameras as well.

Christoph Oberschneider. *Dolomites, Italy, 2015.* ***With zone focusing*** *you can be ready for an action shot by focusing in advance, if you know approximately where the action will take place. Suppose you are on a ski slope and you want to photograph a skier coming down the hill. The nearest point at which you might want to take the picture is 15 ft. (4.5 m) from the action; the farthest is 30 ft. (9 m).*

Line up the distance scale so that these two distances are opposite a pair of f-stop indicators on the depth-of-field scale (with the lens shown at left, the two distances fall opposite the f/16 indicators). Now, if your aperture is set to f/16, everything from 15 to 30 ft. (4.5–9 m) will be within the depth of field and in focus. It doesn't matter exactly where the subject is when you make the photograph, as long as it is somewhere within these distances. Pre-focus an autofocus lens by aiming at a spot the same distance the action will be and holding the shutter button down halfway until you frame and shoot.

Zone focusing for action. Know the depth of field in advance when you want to preset the lens to be ready for an action shot without last-minute focusing. Zone focusing uses a table or the depth-of-field scale on the lens to preset manual focus and aperture so that the action will be photographed well within the depth of field (see below and right).

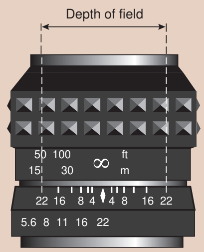


Ansel Adams. *Tetons and the Snake River, Wyoming, 1942.* ***The smaller the aperture the greater the depth of field.*** *Everything in the picture at right is sharp. Adams usually used a view camera (page 13), which offers additional control over focus, and he preferred its large-format film for making prints of greater clarity.*

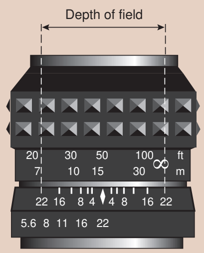
View cameras are always used on a tripod. Even if you are using a small camera, a tripod is a good idea to avoid motion blur when the aperture is small and the shutter speed is correspondingly slow.

Focusing for the greatest depth of field. When you are shooting a scene that includes important objects at a distance as well as close up, you will want maximum depth of field. Shown in the box at right is a way of setting the lens to permit as much as possible of the scene to be sharp. It is easy if you have a lens that has a depth-of-field scale. If not, you can look up the depth of field in a printed table or by using a depth of field application (see below).

Depth-of-field tables *list, for each lens focal length, focusing distance, and aperture, the near and far limits of good focus and the hyperfocal distance (see the box at right). At one time only available as a lengthy book, a full set of depth-of-field tables can now be downloaded as an app (a software program) for your smartphone. You can have complete focus information handy wherever you are. At left is* Simple D-o-F Calculator *on an iPhone.*



When the lens is focused at infinity *(∞ on the lens distance scale), everything at some distance away and farther will be sharp: with this lens at f/22 everything will be sharp from 50 ft. (16 m) to infinity (as far as the eye can see).*



You can increase the depth of field *even more if, instead of focusing on infinity, you set the infinity mark (∞) opposite the point on the depth-of-field scale (22) that shows the f-stop you are using (f/22). You are now focused on a distance (50 ft., 16 m) slightly closer than infinity (technically called the* hyperfocal distance*). Now everything from 23 ft. (7 m) to the far background is within the depth of field and will be sharp in the image.*

Perspective

HOW A PHOTOGRAPH SHOWS DEPTH

Perspective: the impression of depth. Few lenses (except the fisheye) noticeably distort the scene they show. The perspective in a photograph—the apparent size and shape of objects and the impression of depth—is what you would see if you were standing at the camera position. Why then do some photographs seem to have an exaggerated depth, with the subject appearing stretched and expanded (this page, top), whereas other photographs seem to show a compressed space, with objects crowded very close together (this page, bottom)? The brain judges depth in a photograph mostly by comparing objects in the foreground with those in the background; the greater the size differences perceived, the greater the impression of depth. When viewing an actual scene, the brain has other clues to the distances. But, when looking at a photograph, the brain relies primarily on relative sizes.

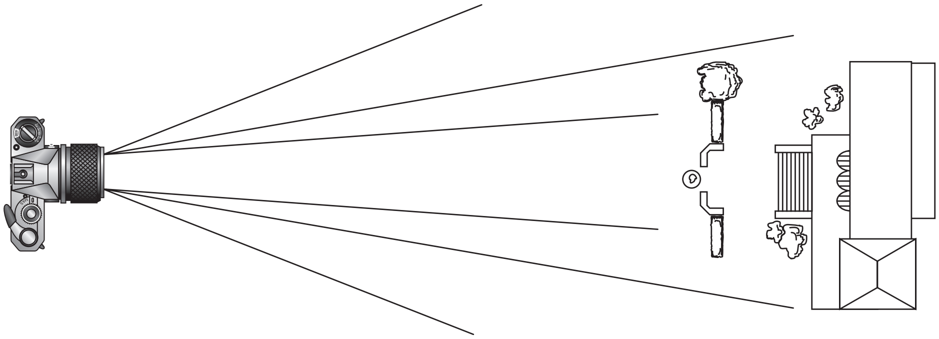
Perspective can be controlled in a photograph. Any lens very close to the foreground of a scene increases the impression of depth by increasing the size of foreground objects relative to objects in the background. As shown opposite, perspective is not affected by changing the focal length of the lens if the camera remains in the same position. However, it does change if the distance from lens to subject is changed.

Perspective can be exaggerated if you change both focal length and lens-to-subject distance. A short-focal-length lens used close to the subject increases differences in size because it is much closer to foreground objects than to those in the background. This increases the impression of depth. Distances appear expanded and sizes and shapes may appear distorted.

The opposite effect occurs with a long-focal-length lens used far from the subject. Differences in sizes are decreased because the lens is relatively far from all objects. This decreases the apparent depth and sometimes seems to squeeze objects into a smaller space than they could occupy in reality.

Walter Iooss. *Ali vs. Terrell, Houston, 1967.* ***Expanded perspective*** *seems to result from the very wide lens. But using any lens this close to a subject stretches distances because it magnifies objects near the lens in relation to those that are far from the lens.*

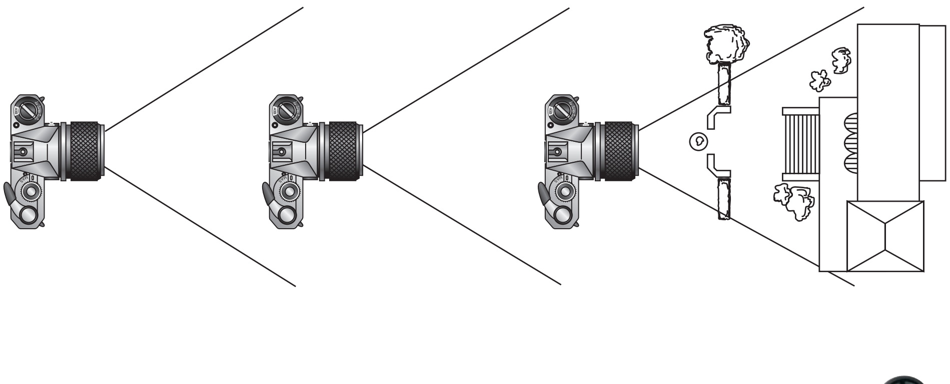
Walter Iooss. *100 m start, Los Angeles, 1983.* ***Compressed perspective*** *is usually associated with a long-focal-length lens. It is because the lens is relatively far from both foreground and background that size differences between near and far parts of the scene are minimized, as is the impression of depth.*



Changing focal length alone does not change perspective*—the apparent size or shape of objects or their apparent position in depth. In the photographs above, the camera was not moved, but the lens focal length was increased. As a result, the size of all the objects increased at a comparable rate. Notice that the size of the fountain and the size of the windows in the background both change the same amount. The impression of depth remains the same.*

Alan Oransky

Lens-to-subject distance controls perspective. *Perspective is changed when the distance from the lens to objects in the scene is changed. Notice how the size of the fountain gets much bigger while the size of the windows remains about the same. The depth seems to increase because the camera was brought closer to the nearest part of the subject.*



Lens Attachments

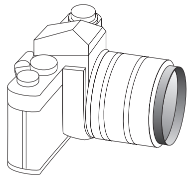
MAKING CLOSE-UPS

Close-up equipment. Shown on the right are different types of close-up equipment you can use to produce a larger-than-normal image on your film or sensor if you don't have a macro lens. All of them do the same thing: they let you move in very close to a subject.

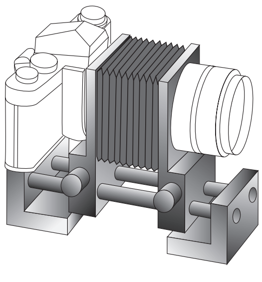
Close-up terms. The closer your camera is to a subject, the larger the image at the focal plane. It is a *close-up* when that image ranges from about 1⁄10 life size (1:10) to as big as life size (1:1). *Macrophotography* generally refers to an image on film or sensor that is anywhere from life size (1:1) to as big as ten times life size (10:1). *Photo-micrography*, photographing through a microscope, is usually used to get an image larger than 10:1.

Depth of field is shallow in close-ups. At very close focusing distances, perhaps an inch or less of the depth in the scene may be sharp, even at your smallest aperture. The closer the lens comes to the subject, the narrower the depth of field (the more the background and foreground go out of focus). Accurate focusing is essential or the subject may be out of focus altogether. Moving the camera slightly forward or back may help to get precise focusing. Smaller apertures, as they will at any other distance, increase the depth of field, but stopping down also increases the exposure time. It may be necessary to use a tripod and, if you are photographing outdoors, to shield your subject from the wind to prevent its moving during the exposure.

***A macro lens** is your best choice for sharp close-ups. If you don't have one, there are several other ways to get close to your subject.*



***A close-up lens** attaches to the front of a camera lens. They come in different strengths (measured in diopters); the higher the diopter number, the closer you can focus. Close-up lenses are relatively inexpensive and small, but image quality will not be as good as with other close-up methods.*



***Bellows** (and similar extension tubes) fit between the lens and the camera to increase the distance from the lens to the film; the greater this distance, the closer you can bring the lens to the subject. Extension tubes come in fixed sizes; a bellows is more adaptable because it can be expanded to any length. Using either extension tubes or bellows requires increasing the exposure; see the text opposite.*

Martin Parr. *Budapest, 1997.* ***In a close-up photograph,*** *the image on the film or sensor is 1⁄10 life size or larger. In an 8 × 10-inch print, the fingers would be a little larger than life size. Many standard camera lenses don't let you get close enough to a subject to make it that big, so you may need a macro lens or other close-up equipment (right). Parr used a flash mounted close to the lens to avoid an unintentional shadow of the camera on the subject.*

Laurisa Galvan. *Gold teeth, Dallas, Texas, 2011.* ***Getting close can often make the strongest photograph,*** *as in this image of a man showing off his "grill" in South Central Dallas. Although not then a resident, Galvan began to document the notorious neighborhood for an assignment in her college photography class. Now a daily fixture on the street corners and accepted as a local, she has continued the project for several years.*

Increased exposures are always needed for close-ups. Regardless of the method—a macro lens, extension tubes, or a bellows—you must move the lens farther from the film or the sensor to focus closer to a subject. But the farther the lens is extended, the dimmer the light that reaches the light-sensitive surface, and the more you must increase the exposure so the result will not be underexposed.

A camera that meters through the lens will increase the exposure automatically. But if the close-up attachment breaks the automatic coupling between lens and camera or if you are using a hand-held meter, you must increase the exposure manually; follow the recommendations given by the manufacturer of the tubes or bellows.

Use a tripod whenever you can. Because depth of field is limited in close-ups (see page 40), you will often want to use smaller apertures to increase it. Exposures, then, risk motion blur because they are often longer than normal. A tripod will prevent camera motion during exposure. If you are using film, read about reciprocity failure (page 74) to make sure your long exposures are correct.

Making the subject stand out from the background. Because a close-up is usually one small object or part of an object, rather than an entire scene, it is important to have some way of making the object you are photographing stand out clearly from its background. Move your camera around to view the subject from several different angles; you may find that from some positions the subject will blend into the background, whereas from others it becomes much more dominant. Shallow depth of field can be an asset in composing your picture. You can use it to make a sharp subject stand out distinctly from an out-of-focus background as in the photograph on page 40. Tonal contrast of light against dark, the contrast of one color against another, or the contrast of a coarse or dull surface against a smooth or shiny one can also make your close-up subject more distinct.

Lighting close-ups. Indoors or out, direct light shining on a subject can let you use smaller apertures for greater depth of field. If you want to bring out texture, light angling across the subject from the side will pick out every ridge, fold, and crease. Direct light can be very contrasty, though, with bright highlights and too-dark shadows. If this is the case, fill light can help lighten the shadows (see pages 130–131). Close-up subjects are small, so using even a letter-sized piece of white paper as a reflector can lighten shadows significantly.

To copy a flat subject, such as a page from a book, illumination should be even. Two lights of equal intensity, one on each side of the subject, at the same distance and angle, will light it uniformly.

Lens Attachments

USING FILTERS

Filters for black-and-white film photography. Most black-and-white films are *panchromatic*—sensitive to all colors to about the same extent that the human eye is. Blue colors, however, tend to record somewhat lighter than we expect them to in black-and-white photographs. Use a filter to darken a blue sky so that clouds stand out more distinctly (shown opposite). Any colored filter with black-and-white film will lighten objects of its own color and darken objects that are opposite in color. The chart below lists some of the filters commonly used in black-and-white pictures.

Filters for color film photography match the color balance of the light source to the color balance of the film (see pages 56–57). Using an FL (fluorescent) filter on the lens, for example, decreases the greenish cast of pictures taken under fluorescent light. If your color film will be printed digitally it is just as effective to adjust the color during editing.

Increasing exposures when filters are used. Filters work by removing some of the light that passes through them. To compensate for the resulting loss of light, the exposure must be increased to prevent underexposure. If you are using a hand-held meter, increase the exposure by the number of stops shown in these charts or as recommended by the filter manufacturer. To review changing exposure by stops, see page 22.

Instead of giving the number of stops you need to increase the exposure, some sources do the same thing by giving you a filter factor. The factor tells how many times the exposure should be increased. A factor of 2 means the exposure should be doubled (a one-stop change). A factor of 4 means the exposure should be increased four times (a two-stop change). See chart this page.

Increasing exposures with a through-the-lens meter. If you are using a camera with a through-the-lens meter, you may not get a good exposure if you meter the scene with a filter on the lens. The sensor in the camera that reads the amount of light may not respond to the color of light in the same way film does. Generally, the sensor will give an accurate exposure reading with lighter filters but not always with darker ones that require several stops of exposure change. A red filter, for example, requires three stops extra exposure when used in daylight with black-and-white film, but some cameras give only two stops more exposure if they meter through that filter. The result: one stop underexposure and a thin, difficult-to-print negative.

Here's how to check your camera's response if you plan to use one of the darker filters. Meter a scene without the filter and note the shutter speed and/or f-stop. Now put the filter on the lens and meter the same scene. Compare the two readings and adjust the settings manually, if needed, when using that filter.

Glass filters attach to the front of the lens and are made in sizes to fit various lens diameters. Look on the ring engraved around the front of the lens; its filter size (in mm) usually follows the symbol Ø. Gelatin filters come in squares that can be cut to various sizes. They can be taped onto the front of the lens or fit into a filter holder. Glass filters are convenient, sturdier, and more protective, but they are usually more expensive.

If filter has a factor of...	Increase exposure this many stops
1	0
1.2	⅓
1.5	⅔
2	1
2.5	1⅓
3	1⅔
4	2
5	2⅓
6	2⅔
8	3
10	3⅓

Filter factors. *You need to increase the exposure when using most filters. Sometimes this increase is given as a filter factor. If so, see chart above for how many stops the exposure should be increased.*

Filters for Black-and-White Film

		Type of Filter	Exposure Increase Needed
To darken blue objects, make clouds stand out against blue sky, reduce bluish haze in distant landscapes, or make blue water darker in marine scenes	Darkens blue objects for a natural effect	8 (yellow)	1 stop
	Makes blue objects darker than normal	15 (deep yellow)	1⅓ stops
	Makes blue objects very dark	25 (red)	3 stops
To lighten blues to show detail, as in flowers; to increase haze for atmospheric effects in landscapes		47 (blue)	2⅔ stops
To lighten reds to show detail, as in flowers		25 (red)	3 stops
To lighten greens to show detail, as in foliage		11 (yellow-green)	2 stops
To make the tones on panchromatic film appear as your eye sees		8 (yellow)	1 stop

Near right: a blue sky may appear very light in a black-and-white photograph *because film is very sensitive to the blue and ultraviolet light present in the sky.*

Far right: a yellow filter *darkened the blue sky and made the clouds and steam stand out. It will also darken shadow areas, which are bluish in tone because they are lit by skylight.*

A filter removes light of its complementary color. *A yellow filter passes red and green, and holds back blue light making blue-colored objects appear darker.*

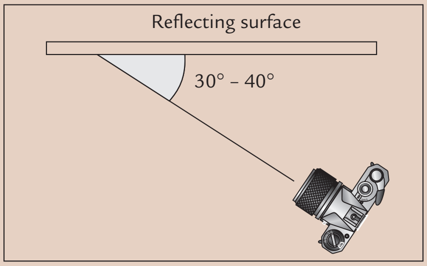
A polarizing filter can remove reflections from glass, water, or any smooth nonmetallic surface. It can decrease haze caused by water vapor or dust in the atmosphere, for sharper, clearer landscapes, and it will darken a blue sky. It may also help to make colors purer and more vivid by diminishing unwanted coloring such as reflections of blue light from the sky. Rotating the filter and altering the angle to the subject affects the amount of these changes. See the box below.

You can see the effects of the filter in the viewfinder of a single-lens reflex or other camera that views through the lens. An exposure increase of about $1\frac{1}{3}$ stops is required. A through-the-lens meter will adjust the exposure correctly if you meter with the filter on the lens.

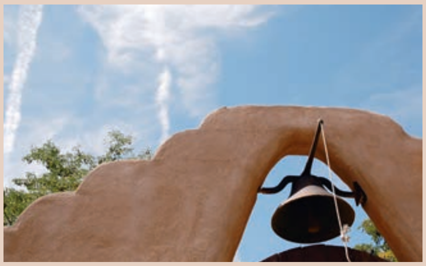
Neutral-density (ND) filters remove a fixed quantity of light from all wavelengths, reducing the overall amount of light that reaches the lens. Use one to set a slower shutter speed or larger aperture than you otherwise could. For example, if you want to blur action but can't use a slower shutter speed because you are already set to your smallest aperture, an ND filter over the lens effectively dims the light, letting you set a slower shutter speed. Similarly, if you want to decrease depth of field but are already set to your fastest shutter speed, an ND filter will let you open the aperture wider.

Other lens attachments for special effects include vignettes, soft-focus attachments, and a cross-screen attachment for streamers of light that radiate from bright light sources.

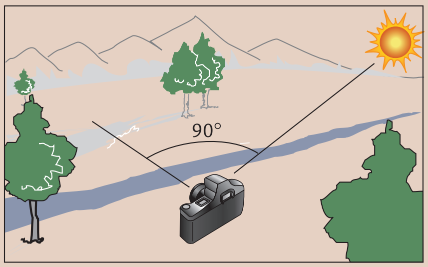
Best Positions for a Polarizing Filter



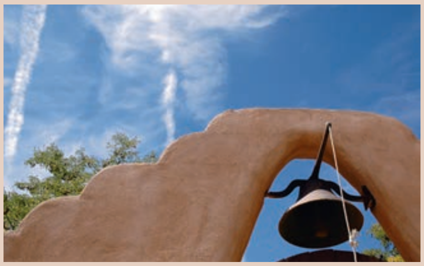
A polarizing filter removes reflections *from surfaces such as glass. The filter works best at a 30°–40° angle to the reflecting surface.*



Without polarizing filter



When shooting landscapes, *using a polarizing filter makes distant objects clearer and the sky darker, as in the example at right. The effect is strongest when you are shooting at a 90° angle to the sun.*



With polarizing filter

ELLIOTT ERWITT
Marilyn Monroe, 1956.