

# PART 1: TECHNICAL

Getting the exposure correct is the first critical skill to master. Is your image too dark? Too light? Just right? This part takes you from pressing the shutter on Auto mode and getting an image with no idea what happened, to being able to control every element of the image making process.

Chapter 1: introduction to exposure

Chapter 2: aperture

Chapter 3: shutter speed

Chapter 4: ISO

Chapter 5: the exposure triangle

Chapter 6: metering

# 1: Introduction to exposure

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A black cat in a coal cellar is the trickiest photo you'll ever take

Aperture, shutter speed, ISO. Auto, Program, Manual. Auto exposure, exposure compensation. How often have you tried to understand all of these camera controls?

By the end of today you will have begun to understand one of them: exposure. Exposure is the foundation on which all of the camera controls are built. In the coming weeks you will pick apart each of the other terms, one at a time, so you understand everything before you move on. But for today you are going to get to grips with exposure, and nothing else.

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## In this chapter

When your camera takes a photo, light comes in through the lens and falls on the sensor, where the image is recorded.

The camera is able to measure the amount of light coming in to make sure the correct amount hits the sensor. This is what *exposure* means - how much light is needed on the sensor so that the photograph is not too dark or too light.

*In this chapter you will learn one thing - how does the camera decide what the correct amount of light is for each photograph it takes?*

This concept is often left until the end of many photography courses, because it's not

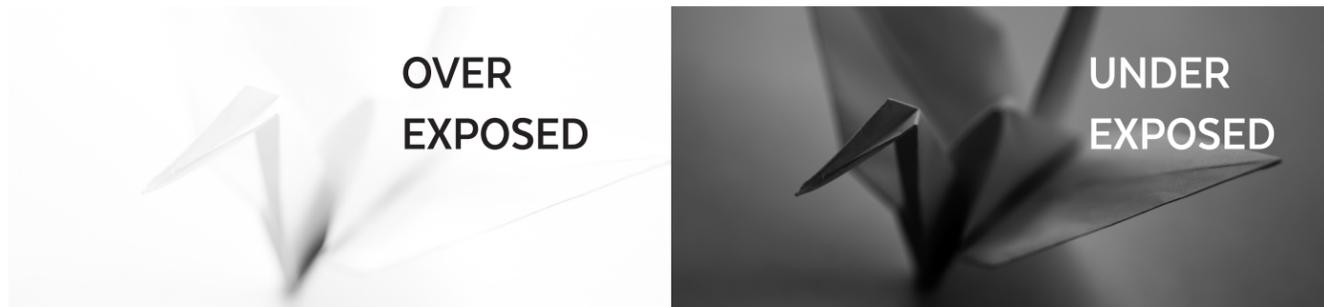
straightforward. But if you understand it right at the beginning, all the remaining chapters will be much easier to follow and your progress will be much quicker.

If it doesn't all sink in first time through, that's fine. Read it at least twice, do the homework, and then move on - even if you don't fully understand everything. But keep coming back to it during the year, until you have the "Aha!" moment, and you can explain to a 7 year old how to take a picture of a black cat in a coal cellar.

(Have you read the section on page vi, "Read This Before You Start"? If not, please do it now - it will help you in the long run.)

## What exactly is your camera doing when it takes a photo?

The very expensive computer in your camera measures how much light is falling on whatever it is you want to take a photograph of, and then makes sure it lets in exactly the right amount of light through the lens and onto the sensor so that you end up with a photo that is not too light or not too dark. This example is a white paper origami crane on a white background:



## How does it work?

How does the camera know which of those 3 images is the correctly exposed one? Take a minute to think about it. It doesn't have a consciousness to tell it which is an acceptable exposure, and which would be considered too dark or too light, so how does it do it?

Had a think?

The answer is in the programming. What has it been programmed to expose for? Bear in mind that it doesn't know if it is taking a photo of an origami crane, a raindrop on a leaf, or indeed a black cat in a coal cellar. How does it decide?

The answer to this is that it doesn't. And this is where it starts to make mistakes, and where you need to take control of the exposure.

Have you heard about 18% grey? Your camera is programmed to assume every image is made up of an average tone of about 18% grey.

This is a tone composed of approximately 18% grey:

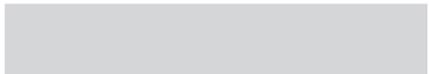


This is the most critical thing you will learn on this course, so take a moment to digest it.

*Every image you take, on auto modes, will default to an overall tone of that grey box. Whether you're taking a dark and moody scene or a bright and airy scene, your camera has been programmed to assume something different: a mid-grey average tone.*

And that's why you're reading this. You are going to learn how to override the camera's programming, so that when you are faced with a scene that is NOT a mid grey tone, you can tell the camera what's going on. When you take control, you will stop getting over or under exposed images.

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Your camera will have been programmed to assume the overall tone of every image you ever take should be this mid grey tone: 

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### What's overall tone?

It's the average of all the tones in the image.

So if you turn your image to black and white and then either blur it, or add up all the different tones of pixel, that's the overall tone.

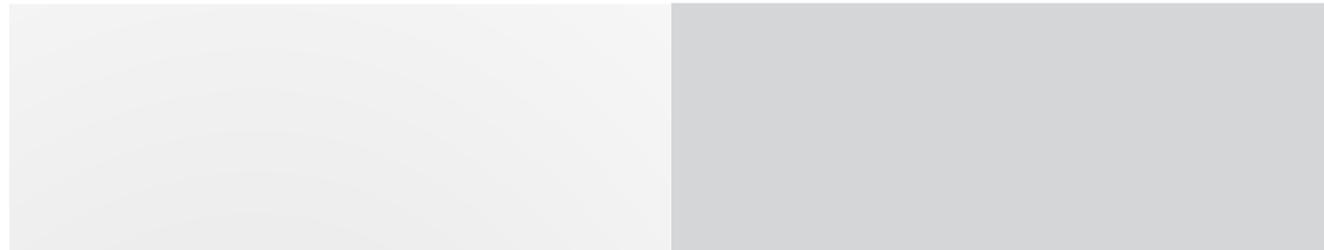
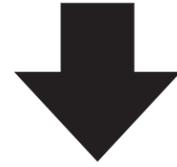
Here's the correctly exposed origami, gradually reduced to its overall grey tone. This is what the camera sees when it looks at the world:



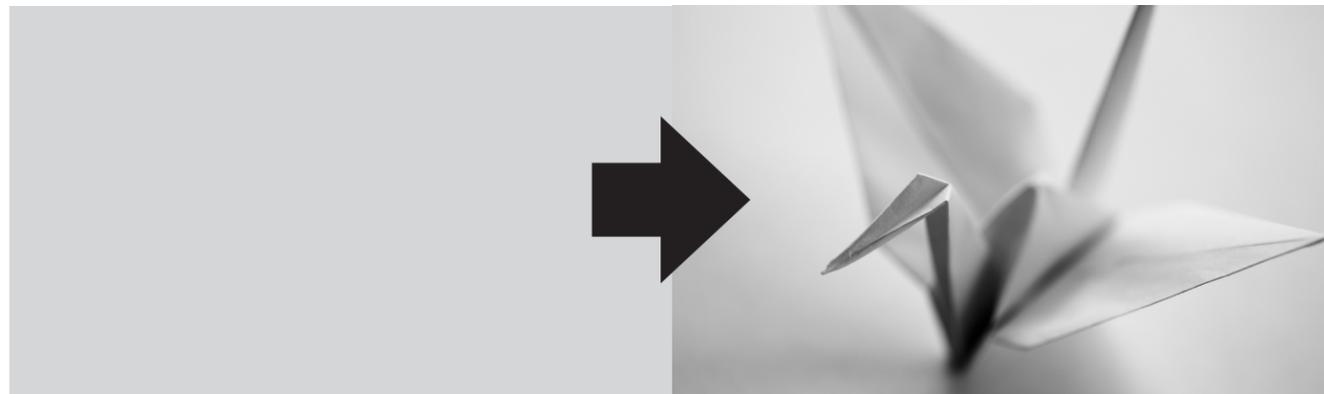
This is what the camera sees when it looks at the origami.



This is the tone that the camera is programmed to turn every photograph into, including the origami.



Without any help from the photographer, the camera will *underexpose* this photograph. It is trying to make the image have an overall tone of approximately 18% grey, even though that's not what you want:



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Just remember that on Auto modes, the camera will expose every image as if it is made up of that 18% grey tone. And that's not always what you want.

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So we come to the black cat in the coal cellar. You should be able to work out how the camera will see this image, by now:



What tone will the camera see the black cat in the coal cellar?

Yes. 18% grey. Overexposed:



Your camera on auto or program mode turns EVERYTHING to 18% grey, whether you want it to or not.

Your job now as a photographer is to:

1. decide whether your scene is going to be approximately 18% grey in tone; and
2. if it's not, decide what you're going to do about it so that you don't end up with an over or under exposed image.

## So what *can* you do about it?

You can take control away from the camera, and override its desire to turn everything it sees to a mid-grey tone.

There are 3 controls you'll learn about in the rest of this section - aperture, shutter speed and ISO. Each one allows you (or the camera) to let more (or less) light in through the lens and onto the sensor to create your image. On Program or Auto modes, the camera makes all the decisions. But you can go "off auto" and take control of these settings for yourself.

In the next chapter you'll go off auto as you learn about aperture. For now all you need to understand is that the camera is programmed to expose every scene so that it has an overall tone of about 18% grey, and that there is a solution, which you'll learn in the rest of the book.

### *In my own words...*

Check that you've understood the most important part of this chapter. Explain here, in your own words, why a camera on an auto mode will over expose a photo of a black cat in a coal cellar.

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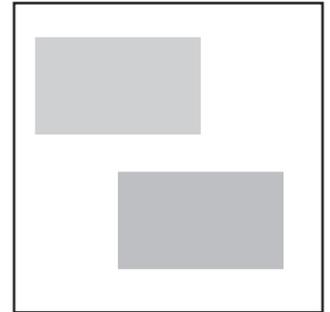
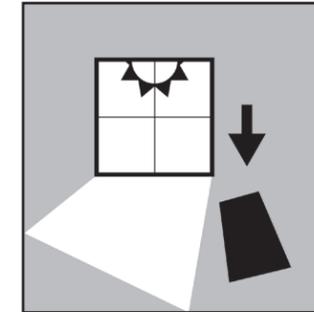
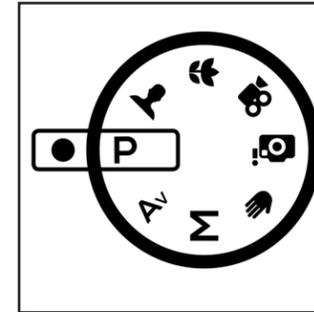
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## Homework

Take 2 photos: one of a piece of white paper, and one of a piece of black paper (use the pages at the end of the book if you don't have paper at home). The aim is to show how the camera will assume each is a mid-grey tone, and create a grey exposure instead of a white/black one.



1. Leave your camera on P (Program) or A (Auto) mode.

2. Make sure each piece of paper is lit in the same way, ideally by placing it next to a window during daylight, but not in direct sunlight. No shadows on the paper, no highlights, and no reflections.

3. Fill the frame with the paper for each shot, so the whole image is either the white paper or the black paper. There shouldn't be any table or background showing.

4. When you've taken the two photographs you should notice that both images are approximately the same shade of mid grey. If they're not, read through the troubleshooting steps below.

## Troubleshooting

### *Does your paper fill the frame?*

If there is anything else in the photo - table, pens, lens cap, shadow - then the camera isn't looking at a completely uniform tone. Try again, and make sure that all you can see through the viewfinder is a rectangle of white (or black) paper.

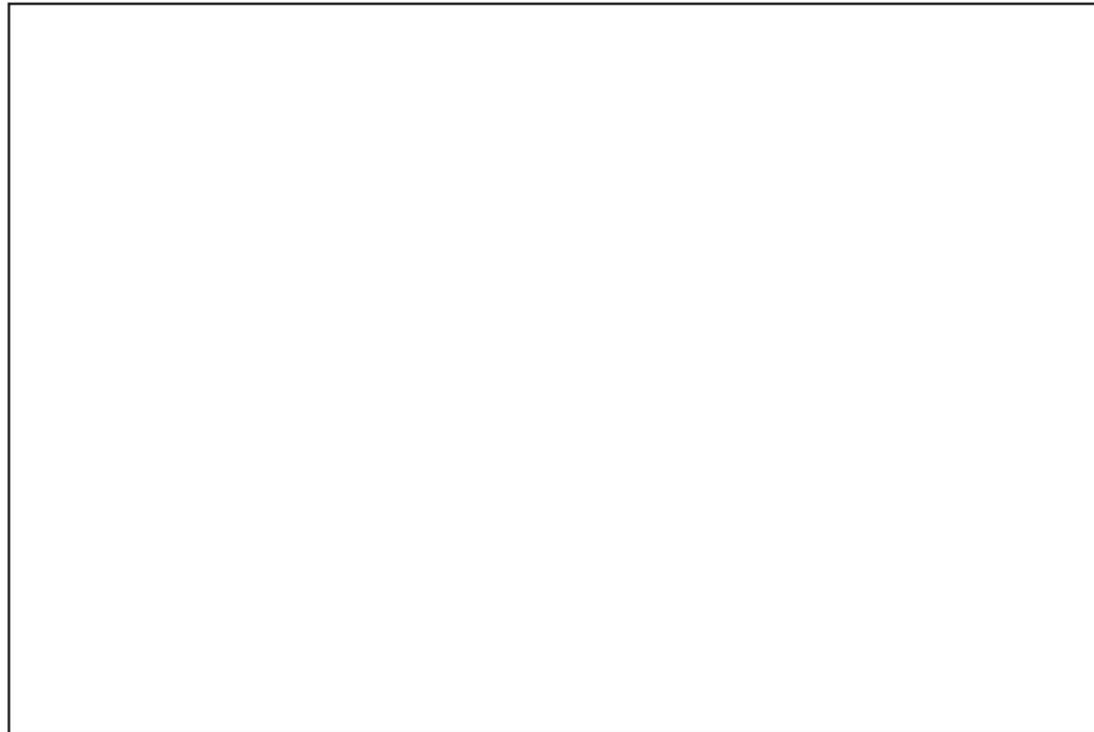
### *Are you on auto or program mode?*

This exercise is designed to show you that the camera defaults to a mid grey tone, no matter what you are taking a photograph of. You must be on one of the automatic modes for it to work. Double check your dial is set to "P" or "Auto".

### *Camera won't focus, or won't take a photo*

Because you are filling the frame with a monotone, your camera might have trouble finding something to focus on. It doesn't matter whether or not the paper is in focus for this exercise, so just put your lens onto Manual Focus for now, and take the photo. Don't forget to switch it back to Auto Focus when you're done. (Look on the side of the lens for the "MF/AF" switch, or if your camera uses the menu system, use your manual to work out how to switch to manual focus.)

Stick your 2 homework photos here:



## Checklist for Chapter 1

- I understand that the camera can measure how much light is falling on a scene
- I understand that the camera doesn't know what it is looking at
- I understand that the camera is programmed to turn every image to an approximate 18% grey tone
- I understand that not every scene I look at will be made up of an approximate 18% grey tone
- I know that a very dark scene (eg a black cat in a coal cellar) is made up of dark tones, and a camera on auto mode will therefore *overexpose* it (trying to turn it to the lighter 18% grey tone)
- I know that a very light scene (eg a polar bear in the snow) is made up of light tones, and a camera on auto mode will therefore *underexpose* it (trying to turn it into the darker 18% grey tone)
- I've done the homework: taken 2 photos, one of white paper and one of black paper
- I've signed up to get the Thursday emails at [AYearWithMyCamera.com](http://AYearWithMyCamera.com) (this is the last reminder)

WE ARE WHAT WE REPEATEDLY  
DO. EXCELLENCE, THEN, IS NOT  
AN ACT BUT A HABIT

~ ATTRIBUTED TO ARISTOTLE



## 2: Aperture

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Aperture - the reason you bought your big camera

As well as controlling how much light hits the sensor, the aperture affects the depth of field of your photograph. This is one of the most creative aspects of photography, and once you can control it you are well on your way to being able to call yourself a photographer.

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### In this chapter

In the previous chapter you learnt about the absolute basics of exposure. How the camera sees the world as grey, and how it is programmed to turn every photo it takes into an average, 18% grey tone.

You had a go at taking photos which should have been all white or all black. You saw how - if left to its own devices - the camera will turn both your white paper and your black paper to a mid grey tone.

Hold onto that knowledge - we'll be coming back to it in Chapter 5. Before we bring it all together, you need to understand 3 other things: aperture, shutter

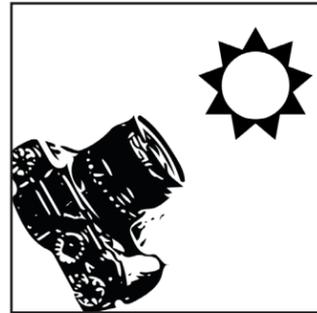
speed and ISO. These are the 3 controls that the camera uses to *change* how much light reaches the sensor when it takes a photograph.

We're going to cover them a chapter at a time, starting today with aperture.

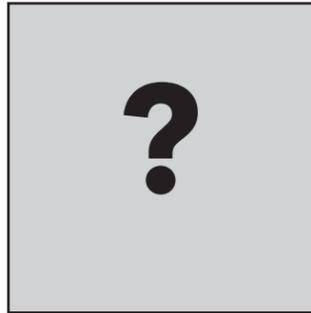
The aperture is an adjustable hole in the lens that can get bigger or smaller, to let in more light or less light. When you change the size of the aperture you not only change how much light is coming in, you also change the *depth of field* of the photograph. And that's what you'll learn about in this chapter.

## What is aperture?

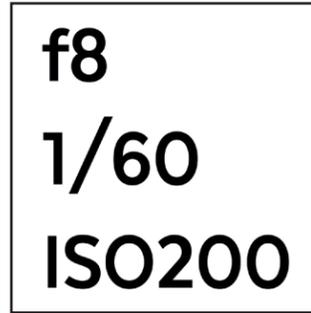
The image-making process (on auto or program modes) goes like this:



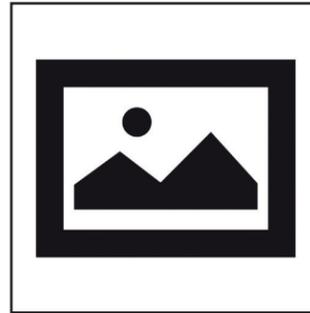
1. The camera measures how much light there is



2. The camera calculates how much light it needs to make the 18% grey image



3. The camera chooses an aperture, shutter speed and ISO which, combined, will create the 18% grey image



4. You press the shutter and get your photo

The aperture is one of the 3 things the camera has at its disposal to control the amount of light hitting the sensor and create an exposure:

- the *aperture* is a hole in the lens which can be made bigger or smaller
- the *shutter speed* is a curtain across the sensor which opens and closes to let light through
- the *ISO* is a measure of how sensitive the sensor is to light

### Why does the camera need 3 different options? Why not just one?

This is the why you have a DSLR, not just a phone camera.

The 3 different options don't just control the amount of light hitting the sensor, they all have a creative effect. And aperture's creative effect is to be able to affect how much of the image is in focus, also known as the *depth of field* of an image.

With shutter speed, you can affect how sharp an image is, and the ISO affects the amount of "noise" or grain in your image.

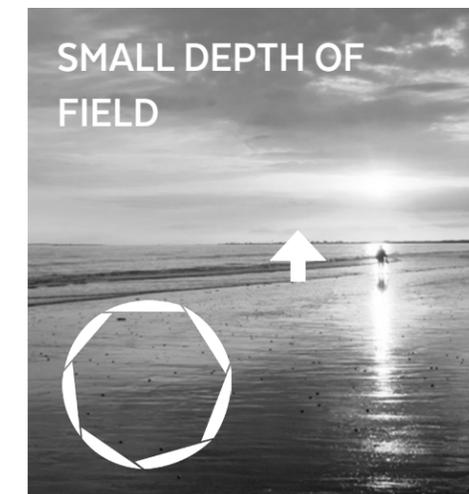
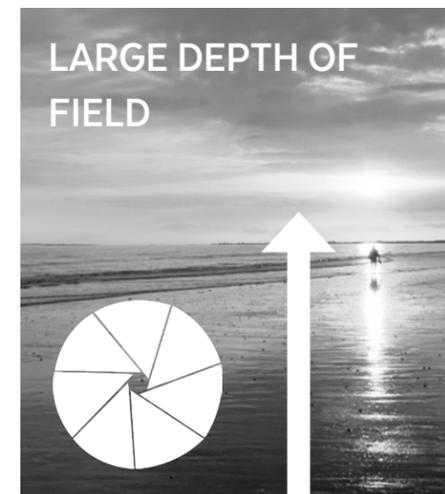
Imagine you're taking a photograph of a beach. You're standing on the beach, pointing your camera straight towards the sunset, with a person walking away from you in the distance. Now imagine a line running directly away from you, towards the horizon. It starts at your feet, travels across the sand, and carries on all the way to the sunset, passing over the person:



This imaginary line is called the depth of field. And the size of the aperture affects which section of that line will be sharply focussed\* in your image. You can decide whether to have everything in focus in the picture, from the sand to the sun. Or whether you just want the person to be in focus.

To have a *large* depth of field, you choose a *small* aperture.

To have a *small* depth of field, you choose a *large* aperture.



\* Technically, the depth of field is which part of the line is "acceptably sharp" to the naked eye - not necessarily what's actually in focus. The two are slightly different. However, you'll often see depth of field defined as what's "in focus".

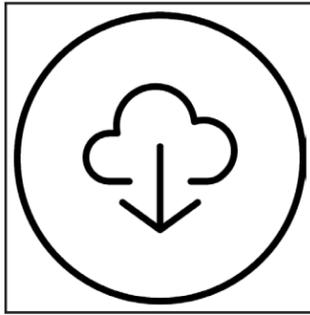
## Aperture priority mode

For this chapter, ignore the fact that aperture affects exposure. Today you are just concentrating on the extra creative effect that aperture has - the ability to affect depth of field. The most common use of depth of field is to blur the background. This is achieved by making sure only the subject falls within the sharp depth of field range, and the background is outside it.

(And this is where 90% of DSLR owners give up. You are not going to be one of the 90%. Read on, understand, and enjoy.)

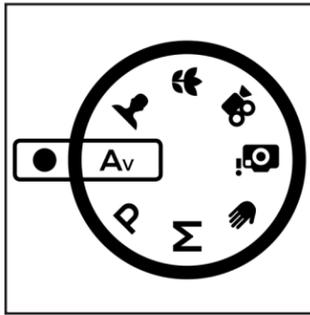
The next thing you are going to ignore, for today, is that your camera (actually, your lens) probably has around 20 different aperture settings. *You are only going to look at the biggest and the smallest.*

Before you try the homework you'll need to find out what the biggest and smallest apertures are on the lens you are using. If it's the first time you've done this, find your camera manual:



1. *Download (or find) your manual.*

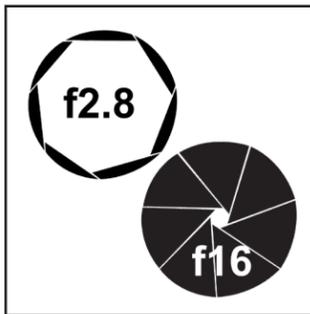
If you can't find it, I have links to all the major manufacturer's manuals on my website, at [AYearWithMyCamera.com/manuals](http://AYearWithMyCamera.com/manuals).



2. *Find out how to put your camera onto aperture priority mode.*

(Or just Google it. eg. "How do I put a Canon 6D onto aperture priority mode?") Hint: for most cameras you just turn the dial that has P, M, S and A on it, to A. Or Av. 'A' usually stands for Aperture, not Auto.

Do it. Put your camera on aperture priority mode. You are now off auto, congratulations.



3. *Go back to the manual and find out how change the aperture.*

Now, scroll through all the aperture settings from beginning to end. Write down the 2 numbers that will be at each end of the list. They might be 5.6 and 11. They might be 2.8 and 16. If you have a very expensive lens they might be 1.2 and 32. (If you are using a zoom lens, pick one end of the zoom and do the whole exercise either zoomed all the way in, or all the way out. The min and max apertures will probably change as you zoom, and I don't want this to confuse you.)

### *The min and max apertures for my lenses*

Write down the name of your lens (eg. 50mm or 35-70mm), and the smallest and biggest apertures for each. You can find the name of your lens by looking around the front of it for a number with "mm" after it.

*eg 50mm: min aperture = f32, max aperture = f1.6*

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### *What are the f numbers?*

The aperture settings are called f-numbers, or f-stops.

These are all the f-stops, in complete increments, in order, from the largest size (smallest number) to the smallest size (largest number). You just have to remember that the large hole = the smallest number, and the small hole = the largest number. No easy way round that.

$f1.4 > f2 > f2.8 > f4 > f5.6 > f8 > f11 > f16 > f22 > f32$

Your camera might give you apertures of f7.1, or f10. These are just fractional f-stops, between the full increments. (Like 2.5 comes between 2 and 3.)

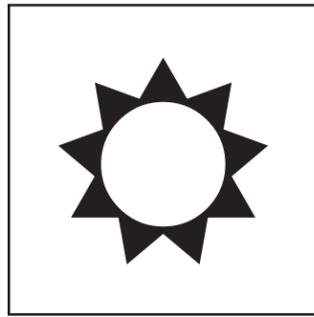
Appendix 1 has a list of all the apertures, full and fractional. I suggest you take a photo of Appendix 1 so you always have it on your phone.

## Homework

Take 2 photos which are exactly the same, except for the aperture. The aim is to see what depth of field is, and how your aperture can control it. This works best with a single subject, like a flower or a cup, set up with a plain background some distance away. You should be able to blur the background with your large aperture photo.

You also need to know that the depth of field starts from the point you focus on, and extends in front and behind that point - so it's very important that you focus on your subject for this exercise, not on the background.

There's no rush. Take it step by step. Go onto aperture priority, dial in f4 or whatever your smallest number is, find your well-lit subject, focus on it, take the photo. Do the same with f16 or whatever your largest number is.



1. You'll need a brightly lit place, ideally out of doors, so you can work with your smallest aperture easily.



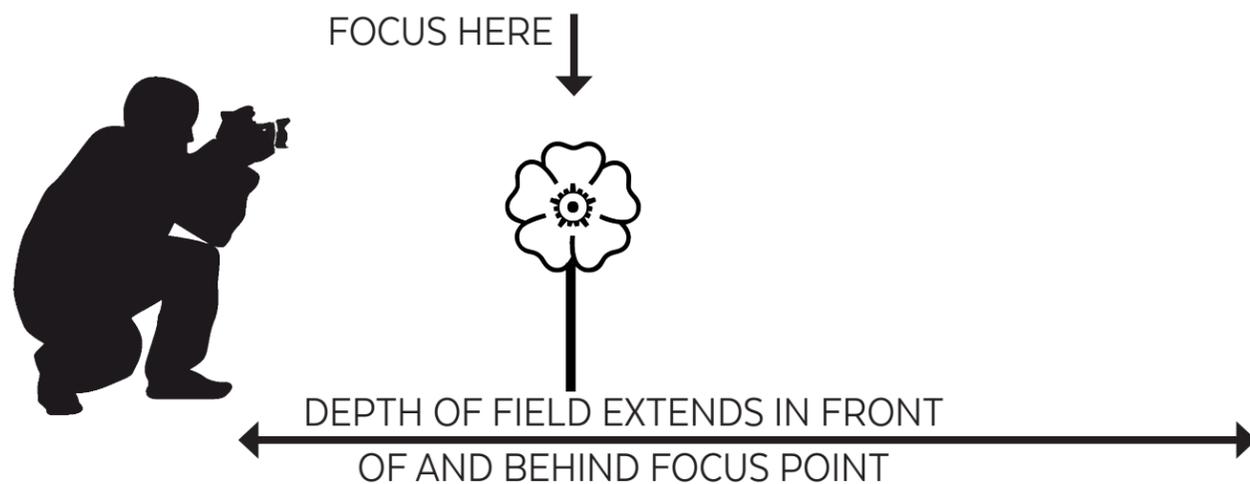
2. Take your first photo on aperture priority, focussing on your subject, and with the largest aperture (smallest number).



3. Take exactly the same photo, but with the smallest aperture (largest number).



4. Your first photo should have a small depth of field and your second photo should have a large depth of field.



## Troubleshooting

*How close are you to the subject?*

With a normal lens (50mm or so), don't stand too far away from the subject. Around a metre, maybe a bit more. If it's really not working, get as close as you can to the subject and still be able to focus on the subject.

*How close is the subject to the background?*

It needs to be probably at least a metre away, but if it won't blur, try moving the subject further away from the background.

*What exactly is your largest number aperture?*

If your largest number aperture is f5.6 or f8, you probably aren't going to see the blurred background effect unless you look very closely at your photo, or move the subject a very long way from the background and stand as close as possible to the subject to take the photo. If you have a cheaper kit lens (one that came bundled with the camera), you might get frustrated with not having a wide maximum aperture to be able to take these kinds of photos. If that's the case, you may have outgrown your first piece of kit. Have a look at a 50mm f1.8 or f2.8, if you want a reasonably priced lens with a wide maximum aperture. But finish Part 1 before you buy any new kit.

*What lens are you using?*

The effect appears more pronounced with longer lenses (100mm and longer). Wide angle lenses (35mm and wider) do create the effect, but you have to stand very, very close to the subject for it to work.

*Have you focussed on the subject?*

Are you quite sure? There's no chance you could accidentally have focussed on the background, or foreground? Put the subject right in the middle of the photo, fill the frame as much as you can, and try again. Switch to manual focus if you need to, and focus by turning the ring on the lens (check your manual for details).

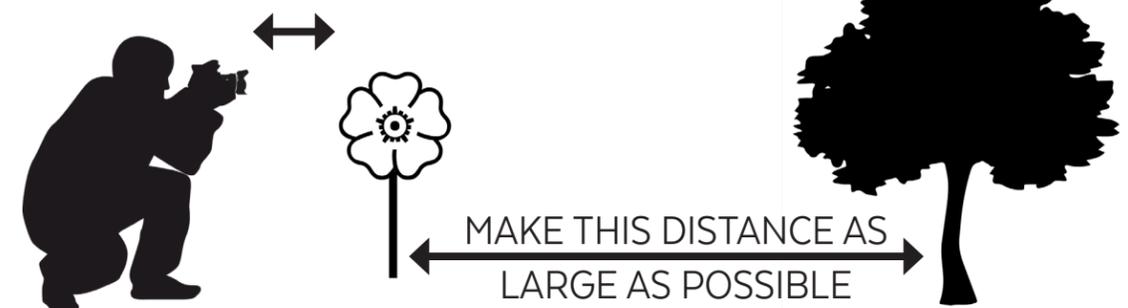
*Photograph is completely over exposed*

If you are working with your largest size aperture (smallest number, eg f4), there might simply be too much light for your camera to cope with. You've effectively reached the mechanical limits of your camera. Solution: move somewhere darker - even just into the shade will help.

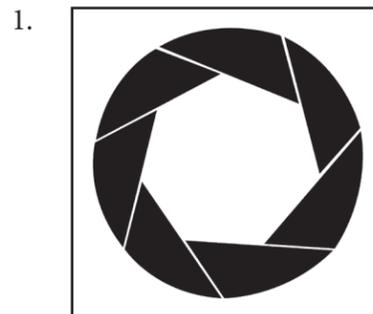
*Photograph is completely under exposed*

The opposite happens with your smallest aperture (eg f22). Move somewhere brighter.

TO BLUR THE BACKGROUND WITH A LARGE APERTURE, MAKE THIS DISTANCE AS SMALL AS POSSIBLE

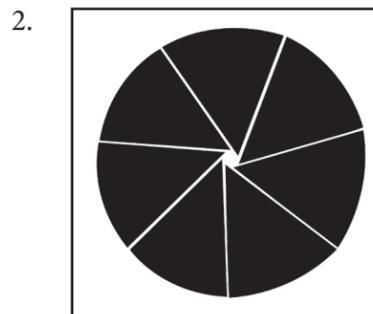


# TEST YOURSELF



This aperture is most likely to be:

- A f4
- B f16
- C f32

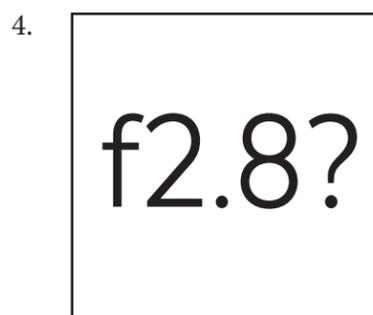
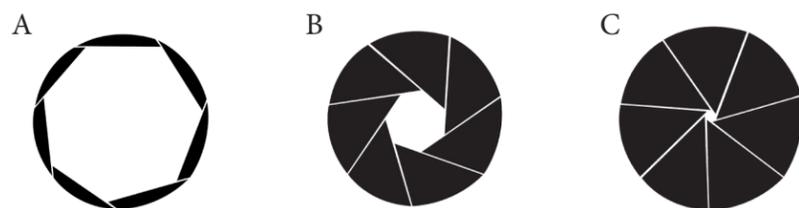


This aperture is most likely to be:

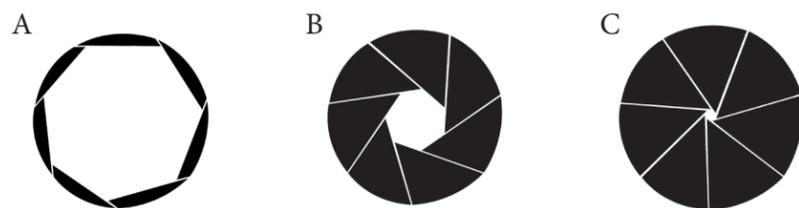
- A f4
- B f5.6
- C f16



Which of these size apertures best represents f8?



Which of these size apertures best represents f2.8?



5. If the photographer is focussing on the flower, with an aperture of f2.8, what is the tree in the background likely to be?

- A Blurred
- B Not blurred



6. If the photographer is focussing on the flower, with an aperture of f32, what is the tree in the background likely to be?

- A Blurred
- B Not blurred



7. Which of these apertures gives the largest depth of field?

- A f2.8
- B f8
- C f22

8. Which of these apertures gives the smallest depth of field?

- A f4
- B f5.6
- C f11

ANSWERS 1: A 2: C 3: B 4: A 5: A 6: B 7: C 8: A

Stick your 2 homework photos here:

## Checklist for Chapter 2

- I can put my camera on Aperture Priority mode
- I can change my apertures
- I know what the smallest and largest apertures are for each of my lenses
- I know that aperture is one of the 3 ways that my camera controls the amount of light coming in through the lens and hitting the sensor
- I know that the aperture is found in the lens, not in the camera
- I know that f4 is a large aperture and that f16 is a small aperture
- I know that the depth of field is the section of an image which is acceptably sharp
- I know that f4 will give a small depth of field and that f16 will give a large depth of field
- I can take a photo of a subject with the background blurred:



# DONE IS BETTER THAN PERFECT



## 3: Shutter speed

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Shutter speed - playing with time

If you need sharp photos, or you want some motion blur, you'll want to understand how shutter speed affects what records on your sensor.

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### In this chapter

We have covered 18% grey - how the camera sees the world. It turns every photo it takes to an average grey tone. Usually that's OK, but sometimes (if you're taking very light or very dark photos), it gives dreadfully exposed images.

In the previous chapter you learned about aperture - the small hole in the lens. If you make it a big hole, not only will it let in more light, but it will also reduce the depth of field (the amount of the photograph in sharp focus). If you make it a small hole, it will let in less light and also increase the depth of field.

In this chapter you'll look at *shutter speed*.

Shutter speed is one of the other things the camera (or you) has under its control. And, just like aperture, as well as being able to control the amount of light hitting the sensor, it has its own creative effect.

With shutter speed, you get control over the amount of blur, or sharpness, in the image. Sometimes you want blur, sometimes you don't. The camera doesn't know whether you do or don't, and it will always, always pick a mid range shutter speed by default. So if you want anything at the extremes - a very blurred image, or a super sharp image, you have to take control.

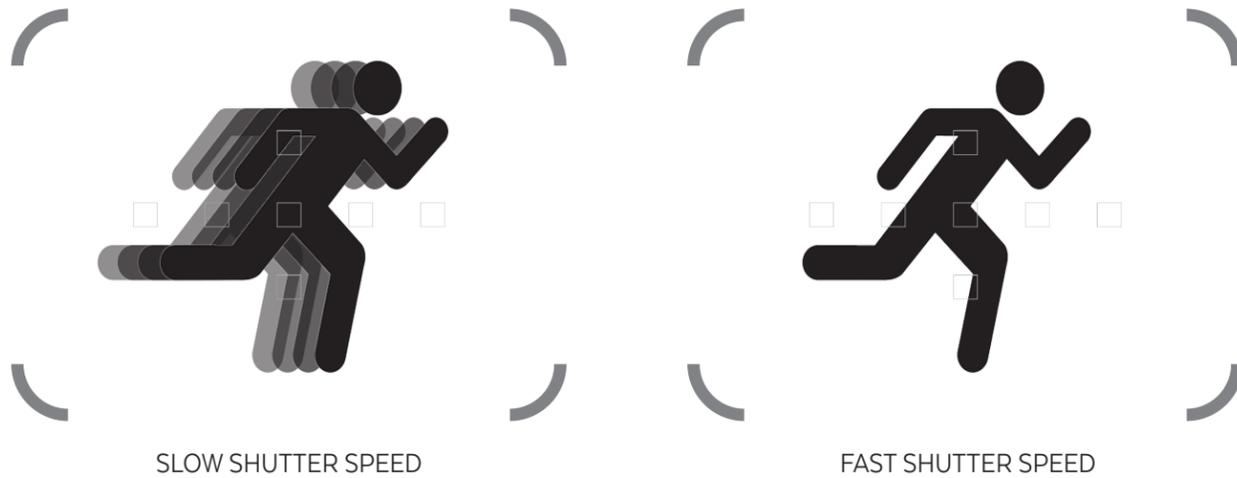
## Fast or slow shutter speed?

The shutter is a curtain that opens and closes in front of the sensor.

A fast shutter speed opens and closes fast. A slow shutter speed opens and closes more slowly.

Can you see that if your subject moves whilst the shutter is open (a slow shutter speed), it will record as a blur? (And also - if *you* move while the shutter is open, you'll cause a blur in the photo even if the subject isn't moving. This is called camera shake.)

And can you see that if your shutter opens and closes in a fraction of a second - faster than the subject is moving - you will be able to freeze the action?



### What are the shutter speeds?

These are common shutter speeds, in complete increments, in order from the slowest (lets most light in) to the fastest (lets least light in). They are measured in fractions of a second.

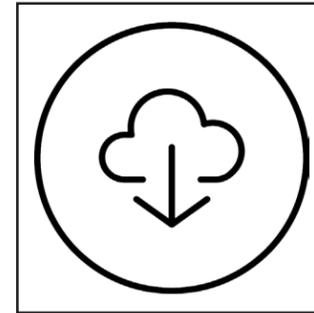
$1/15 > 1/30 > 1/60 > 1/125 > 1/250 > 1/500 > 1/1000$

Your camera might give you different shutter speeds, like 1/50th or 1/160th. These are just fractional speeds, between full increments. (Like 2.5 comes between 2 and 3).

Appendix 1 has a list of all the shutter speeds, full and fractional.

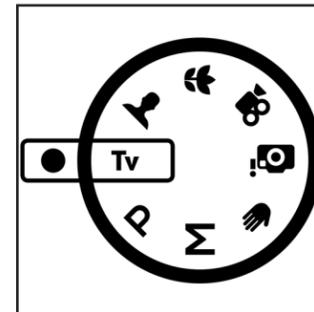
## Shutter priority mode

Before you do the homework, you'll need to know how to change your shutter speed.



1. *Download (or find) your manual.*

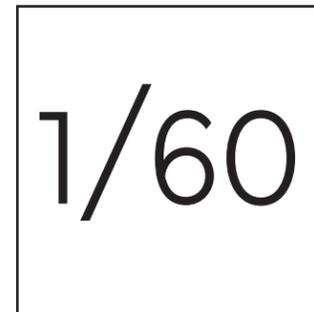
I have links to all the major manufacturer's manuals on my website, at [AYearWithMyCamera.com/manuals](http://AYearWithMyCamera.com/manuals).



2. *Find out how to put your camera onto shutter priority mode.*

This is where you choose the shutter speed, and the camera will pick an aperture. (Google it if you don't want to read your manual: "How to put a Fuji XT1 onto shutter priority mode".)

Do it. Put your camera on shutter priority mode.

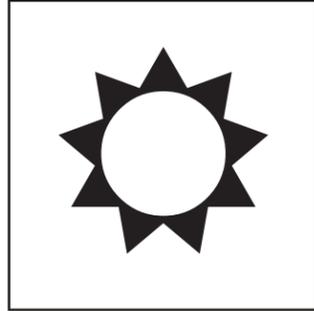


3. *Go back to the manual and find out how change the shutter speed.*

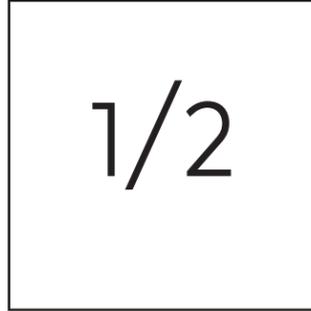
Shutter speeds are measured in fractions of a second, and will be displayed either as "60" or "1/60" (for 1/60th of a second).

## Homework

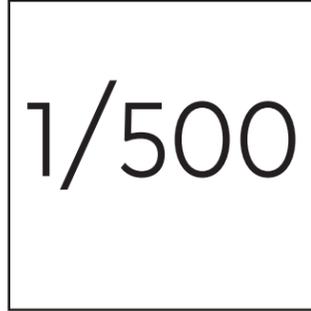
Take 2 photos of the same moving subject, one with a fast and one with a slow shutter speed. The aim is to see what effect changing your shutter speed has on the blur that is recorded in the final image.



1. You'll need a brightly lit place, ideally out of doors, so you can work with your fastest shutter speed easily.



2. Take your first photo on shutter priority, focussing on your subject, and with a slow shutter speed (try something very slow like 1 second, or 1/2 sec).



3. Take exactly the same photo, but with a very fast shutter speed. Try the fastest possible with the available light you have, at least 1/500th, but 1/1000th if you can manage it.



4. You should get one blurred image, and one very sharp image (or at least, your subject is sharp - don't worry about the background).

Pick a subject that's moving reasonably fast - someone running (across the frame, not towards you), a car (careful where you stand), something blowing in the wind, water running from a tap, your dog, or even just someone's waving hand up close.



Slow shutter speed  
1.3 seconds

## Troubleshooting

You should get one photo where the subject is blurred (the one with the longer shutter speed), and one where the subject is sharp (the one with the shorter shutter speed). If not, try these tips:

*Camera won't take a photo at a fast shutter speed*

You don't have enough light - the faster shutter speeds let in only a tiny amount of light and your camera might just refuse to take a photo if there isn't enough light. Try at 1/500th and see if you can get the effect you want, otherwise go outside during the day in a well-lit place.

*Focus won't work*

It can be hard to keep your focus on the subject when the subject is fast-moving. Don't worry too

much about the focus for this exercise. As long as you can take two photographs, one with a blur and one without, it doesn't matter if your focus is off. Try switching to manual focus if you want to get it right

*Photograph is completely over exposed*

If you are working with a long shutter speed (like a whole second or more), there might simply be too much light for your camera to cope with. Just like when you worked with large apertures, you've effectively reached the mechanical limits of your camera. Solution: move somewhere darker.

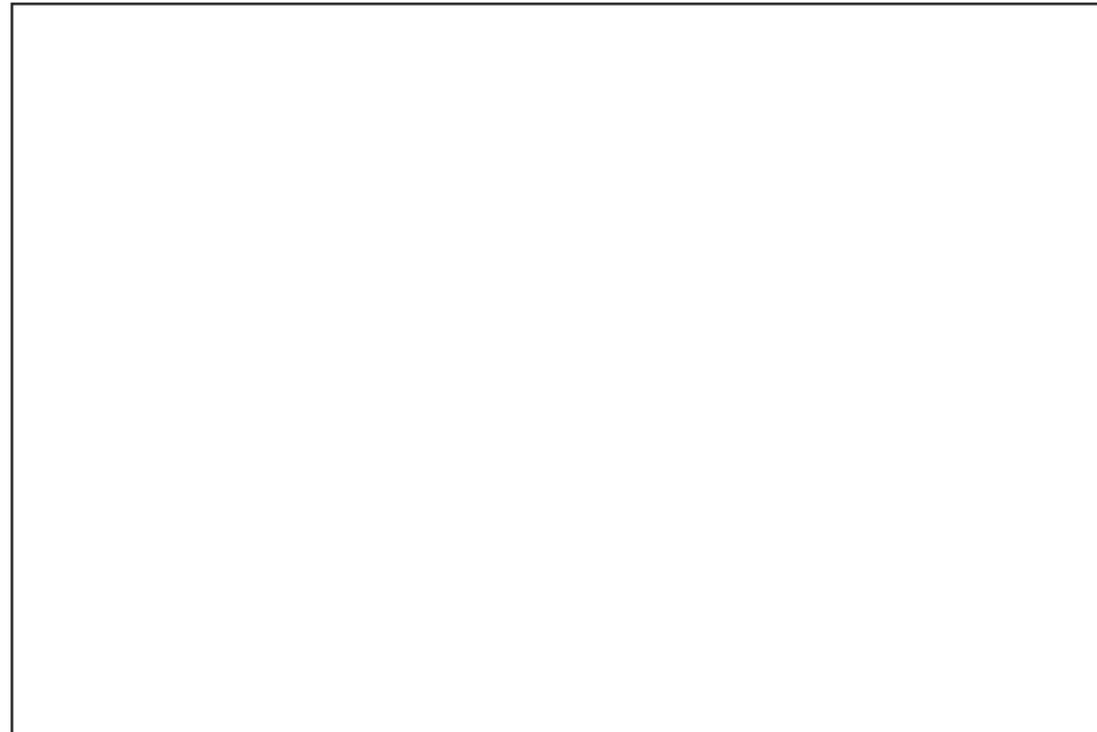
*Photograph is completely under exposed*

The opposite happens with your faster shutter speeds (eg 1/1000th or faster). Move somewhere brighter.



Fast shutter speed  
1/320th second

Stick your 2 homework photos here:



## Checklist for Chapter 3

- I can put my camera on Shutter Priority mode
- I can change my shutter speeds
- I know that shutter speed is one of the 3 ways that my camera controls the amount of light coming in through the lens and hitting the sensor
- I know that the shutter is found in the camera, just in front of the sensor
- I know that a whole second is a very long shutter speed
- I know that 1/2000th second is a very short shutter speed
- I know that shutter speed affects the amount of blur, or camera shake, in an image
- I know that a shutter speed of a whole second will create lots of blur if either the subject or the camera is moving
- I can take a photo with the subject blurred:



GREAT THINGS ARE DONE BY  
A SERIES OF SMALL THINGS  
BROUGHT TOGETHER

~ VINCENT VAN GOGH



## 4: ISO

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The easiest part of exposure to understand

Once you know what it is, you can forget about ISO for most of the time. But when you need it, you'll be glad you know how to use it.

---

### In this chapter

The camera has 3 options when it comes to controlling the amount of light hitting the sensor and making the photograph: aperture, shutter speed and ISO.

The first two are mechanical options that physically control the amount of light. ISO is digital.

The ISO is the degree of sensitivity of the sensor. It can be changed between photos, and is best seen as a useful backup option to have in extreme light conditions (very bright or very dark).

The most difficult thing to learn when it comes to ISO is how to change it. On many cameras you have to hold a button and turn a dial at the same time. It's a critical skill to learn though, and it will come easily with practice.

## What is ISO?

ISO (stands for International Standards Organisation) is a *measure of sensitivity*.

In the days of film cameras, the film you chose had a fixed sensitivity to light, called the ISO. A low ISO (50) was used in very bright conditions (not very sensitive to light). A high ISO (1600) was used in darker conditions (more sensitive to light).

Nowadays, ISO refers to the sensitivity of the sensor to light. In the days of film you were stuck with the same ISO until you'd finished your roll of 24 or 36 shots. If you moved from the beach to inside a museum, your ISO would be wrong. But with digital, you can change the ISO for every shot if you want to.

## Why not just stick your ISO on high and leave it?

The downside of using a high ISO (very sensitive) is the noise. In the days of film, it was called grain, and made those arty black and white shots so memorable.

Nowadays it's not as attractive, and the amount of noise that you get is entirely dependent on how expensive your camera was. You might have wondered why some cameras are so much more expensive - one reason is the quality of the

sensor, and the degree to which the image quality deteriorates with noise at higher ISOs.

So, whilst aperture and shutter speed had creative effects as well as affecting the amount of light reaching the sensor, ISO really just has a potential downside. Remember that the higher ISO you use, the more the quality of your photo will degrade.

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A high ISO lets more light in (like having a wide aperture or a slow shutter speed), but the quality of your photograph will deteriorate due to noise.

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## How to change ISO

There is no 'ISO priority mode', like you have aperture or shutter priority modes.

Exactly how to change your ISO will depend on your camera, so make sure you have your manual ready. Some cameras have a button or a dial to change the ISO: for others it's accessed through a menu.



## The easiest method - Auto ISO

If your camera is newer (or more expensive), you might have Auto ISO mode. This means that whatever mode you are using, the camera will automatically choose the lowest possible ISO.

You can also change the defaults in the settings, to limit the upper ISO. This is useful if you definitely don't want to go above a certain ISO. I usually have my upper ISO set to 400 for a professional shoot, and no limit for personal shoots. On professional shoots the quality of the images is critical, and I must use other ways of getting the shot rather than relying on

high ISOs, but for personal work I'd often rather get the shot no matter what the ISO.

Just be aware that on some cameras, on some modes, Auto ISO won't work. For example, it might only work on Program or Auto mode, not on Shutter or Aperture priority. This is where you need to read your manual. First, find out if you have Auto ISO. Then find out if there are any times when it won't work.

## Manual ISO

If you don't have Auto ISO, you'll need to know how to change your ISO manually. Look it up. It's probably a button on the top of your camera (marked

"ISO"), and then one of the dials to increase/decrease. Don't forget to put it back to a lowish ISO (200) once you've finished.

## When to change ISO

You might have noticed, especially on the shutter speed exercise in the last chapter, that when you were at extremes (very high or low shutter speed), you got images that were too bright or too dark (overexposed or underexposed).

This happened because your camera had reached its mechanical limits. If you were outside and using a very long shutter speed during the middle of the day, your camera would have selected the tiniest aperture possible to compensate for the very long shutter speed. But at some point, it would not be able to make the aperture any smaller, and because you were using a long shutter speed, light would continue to pour into the camera and onto the sensor, overexposing the photograph.

In this situation, you need to make the ISO LESS sensitive to light (make it a smaller number). It's like putting a pair of sunglasses on your camera's sensor - a low ISO lets it cope with very bright conditions.

Alternatively, if you were on aperture priority and using a tiny aperture to get a big depth of field, at some point your camera will not be able to use a long enough shutter speed to compensate, and your image will be too dark. Or, more likely, you won't want to use a longer shutter speed because you'll get camera shake.

In this case, if you didn't have a tripod to allow you to use a long shutter speed, you'd increase your ISO to make the sensor *more* sensitive to light.

## Homework

### Step 1

Work out how to change your ISO manually. Also find out if you have Auto ISO, and whether it doesn't work on any of your modes.

### Step 2

Pick either the shutter speed or aperture exercise from the last 2 chapters, and do it again but with ISO as a backup. View your photos on a computer screen at 100% so you can check the noise.

Let's say you decide to try the shutter speed exercise again. On your fastest shutter speed (let's say 1/2000th), you might have found your images too dark. Go into your ISO settings, and change your ISO to it's highest possible setting (eg ISO 12,800). Don't worry about the fact your images will be full of noise - the purpose of this exercise is just to see how changing your ISO gives you a backup option.

For the slow shutter speed (eg. 1 second), change your ISO to the lowest possible setting (eg ISO 100). The effect won't be as noticeable at the low settings because your camera will already be picking a low ISO for you if possible. With some cameras you might find the lowest ISO is something like 200, but that you can take it down to 100 or even 50 by changing a custom function or one of the menu settings. Check your manual, because this is a very useful option when you're working in very bright conditions.

For the aperture settings: for the biggest aperture (smallest number, eg. f4), you'll need to reduce the sensitivity of the sensor to compensate for all that light pouring in, so pick a low ISO (ISO 100). For the smallest aperture (biggest number, eg. f22), you'll want to increase the sensitivity of the sensor, so pick a high ISO (ISO 12,800).

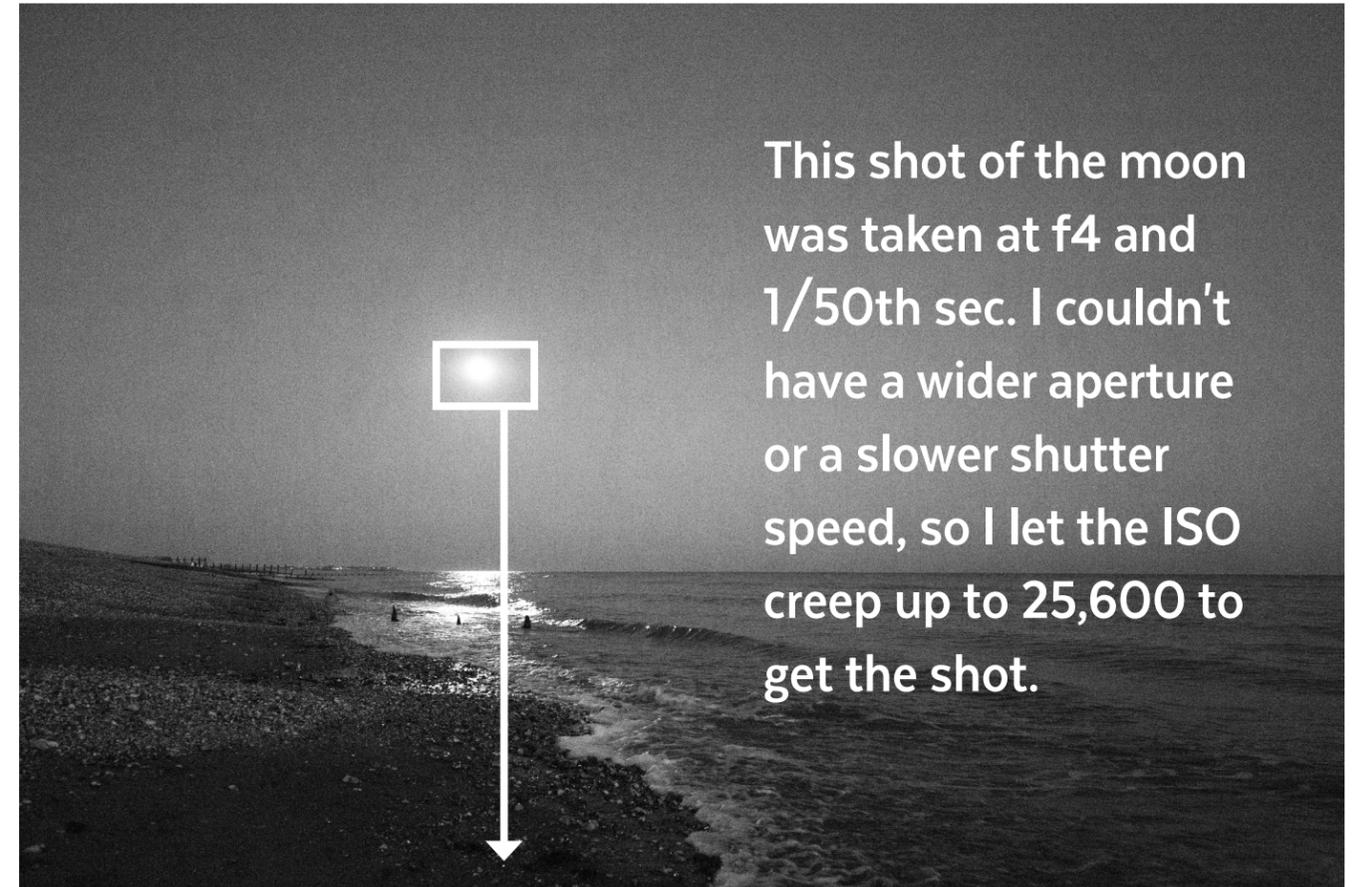
### What are the ISO settings?

These are the ISO settings, in complete increments, in order from the least sensitive (lets least light in; use in bright conditions) to the most sensitive (lets most light in; use in dark conditions).

50 > 100 > 200 > 400 > 800 > 1600 > 3200 > 6400 > 12800

Your camera might give you ISOs of eg. 160, or 500. These are just fractional ISO measurements, between the full increments. (Like 2.5 comes between 2 and 3.)

Appendix 1 has a list of all the ISO settings, full and fractional.

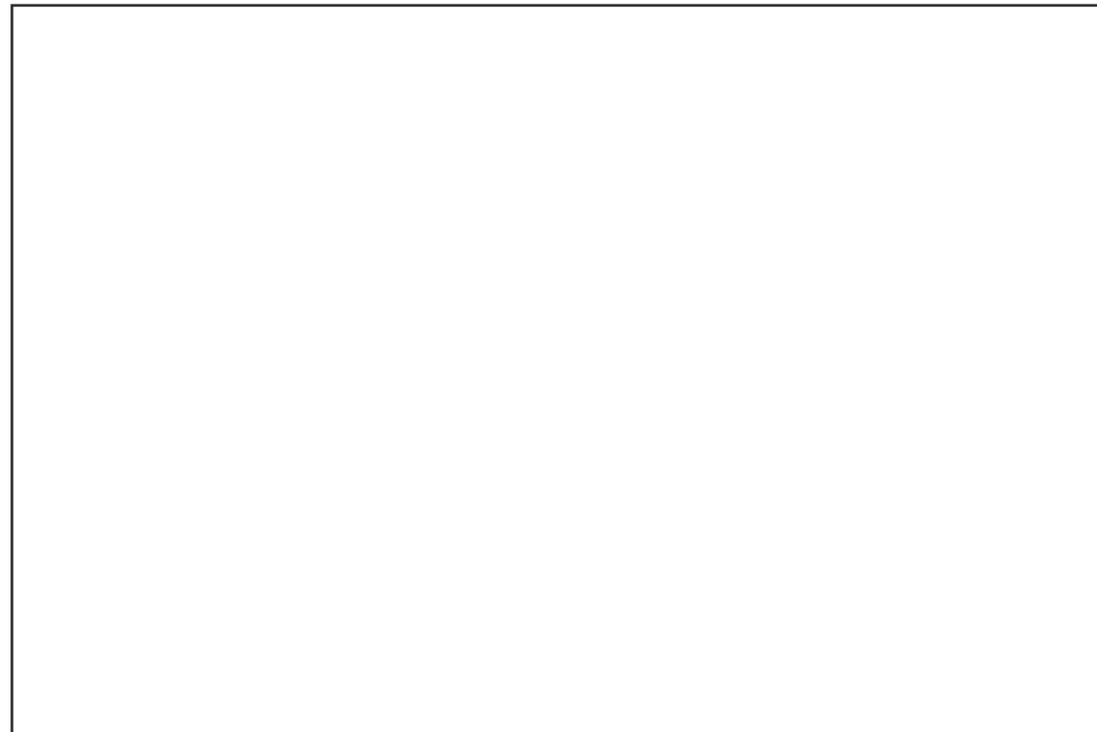
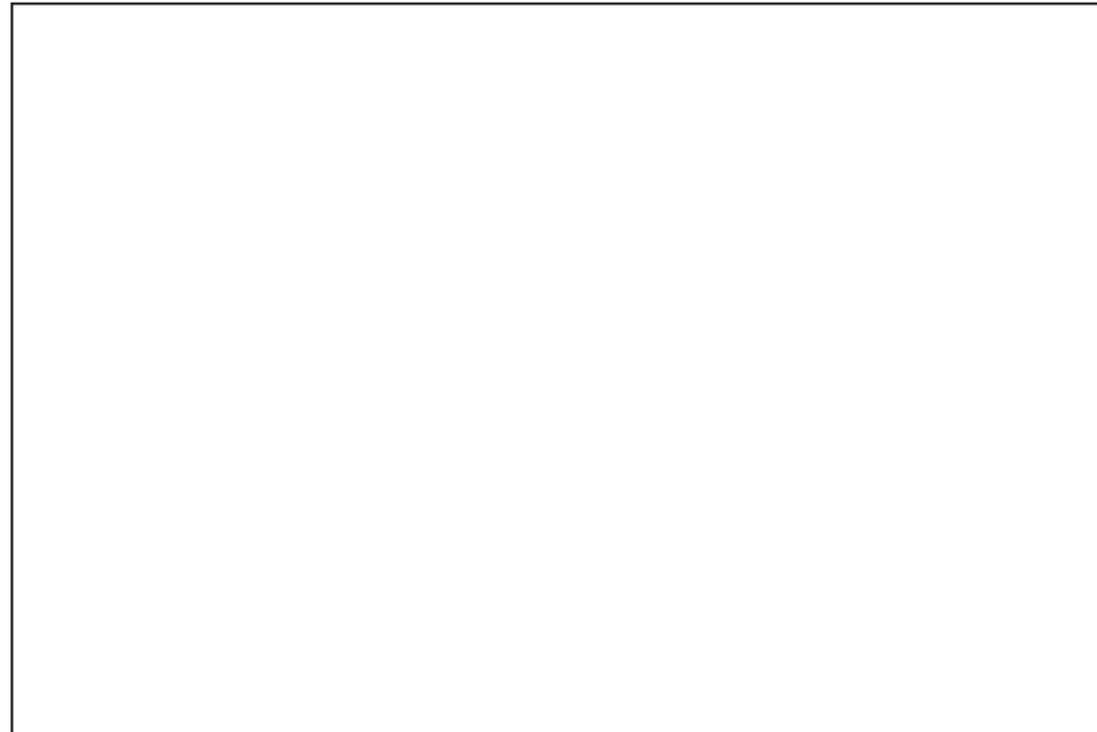


This shot of the moon was taken at f4 and 1/50th sec. I couldn't have a wider aperture or a slower shutter speed, so I let the ISO creep up to 25,600 to get the shot.



When viewed at 100%, the ISO 25,600 image is full of noise.

Stick your homework photos here:



## Checklist for Chapter 4

- I know that ISO is one of the 3 ways that my camera controls the amount of light needed for a correct exposure
- I know that the ISO is a measure of the sensitivity of the sensor for a particular photograph
- I know that ISO 50 is a low sensitivity, and should be used in very bright conditions if I can't use a smaller aperture or a faster shutter speed
- I know that anything above ISO 1600 is a high sensitivity, and should be used in dark conditions if I can't use a wider aperture or a slower shutter speed
- I know that a higher ISO creates more noise in my image
- I can change my ISO without looking it up in the manual
- I have tried either the aperture or the shutter speed homework again, using ISO as a backup to help with the extreme settings

THE GREATER DANGER FOR MOST  
OF US LIES NOT IN SETTING  
OUR AIM TOO HIGH AND FALLING  
SHORT; BUT IN SETTING OUR  
AIM TOO LOW, AND ACHIEVING  
OUR MARK

~ ATTRIBUTED TO MICHELANGELO



## 5: Exposure triangle

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3-way balance

Taking control, becoming a photographer.

---

### In this chapter

You've learnt so far that exposure = aperture + shutter speed + ISO.

On auto modes (including aperture and shutter priority), your camera decides what the correct exposure is. You will remember from the first chapter that it assumes the world is made up of a single mid grey tone.

On fully auto mode, your camera decides which combination of aperture and shutter speed (and ISO, if you have Auto ISO) will be used to get the exposure it needs. And, given a chance, it will never, ever choose any settings at the extremes. You will never get the camera choosing a shutter speed of half a second; it is protecting you from camera shake. It will never pick an aperture of f2.8 or a high ISO unless it has no other option; it is protecting you from an out of focus subject and a grainy photo.

It will always pick middle of the road settings unless it is very dark or very light. You'll be stuck with f8, 1/250th and ISO200. So if you ever want to use f2.8 or f22, with a shutter speed of 1/4000th or 2 seconds, or any other combination of extreme or specific settings, you'll need to go off auto altogether.

In this chapter you'll shoot on fully Manual, take control, and you will be able to call yourself a photographer.

This is one of the most complicated chapters in the book, so please take it one step at a time. You don't need to remember everything - as long as you understand it as you are reading it, that is fine at this stage. The main concept to understand is that you can balance changes in aperture with changes in shutter speed or ISO.

## What is the exposure triangle?

Imagine a 3-way seesaw (teeter-totter). If one corner goes up, the other 2 corners have to go down by an equal and opposite amount. This is exactly the same for camera settings, and it's known as the exposure triangle.

If aperture, shutter speed and ISO are the 3 corners, and one goes up (let's say you want a shallow depth of field so you pick a large aperture), then, to keep the same exposure, the other 2 need to go down to

compensate. If you are on aperture priority mode, or shutter priority mode, the camera does the compensation for you. If you want complete control, you will need to shoot on Manual mode.

You don't need to shoot on Manual all the time, but to call yourself a photographer you need to know how to do it. And there will be a few occasions when you need to shoot Manual.

## When should I shoot Manual?

*Shoot on Manual mode when you need to control both aperture and shutter speed.*

You might want both a particular depth of field (eg. you want to use f16) but you also want a little bit of motion blur, so you want a shutter speed of 1/30th. You can't afford to let the camera pick either, so you must pick both.

Or if you shooting macro (close up), you will want to have a much higher shutter speed than normally

needed, because camera shake is magnified along with everything else. The camera won't know this, and will pick a mid range shutter of 1/125 or 1/250, when you actually need 1/1000th or faster.

If you need to replicate exactly the same settings between shots (for example in studio work), you would use Manual mode to fix the settings in place. In a studio you would change the amount of light being used as required, rather than changing the camera settings.

## How to shoot on Manual mode

Find the "M" setting on your dial. Now dial in all 3 settings - aperture, shutter speed and ISO (unless you are using auto ISO). Use your camera manual if you need a reminder of how to change each setting.

Don't forget to put your camera back onto your preferred setting once you've finished (Program,

Auto, Shutter priority or Aperture priority). If you don't do this, and aren't used to shooting on Manual, you'll take some unexpectedly over or under exposed images the next time you go out with your camera.



## Understanding stops

*What are stops?*

Do you remember the list of aperture f-stops? And shutter speeds and ISOs? f4, f5.6, f8; 1/60th, 1/125th, 1/250th; 100, 200, 400?

*The gap between these measures of aperture, shutter speed and ISO is important, and it's called a "stop".*

From f4 to f5.6 is 1 stop. From 1/60th to 1/125th is 1 stop. From ISO 400 to ISO 800 is 1 stop. Each stop lets in the same amount of light. So 1 stop on the aperture scale corresponds to 1 stop on the shutter

*Full stops, half stops and third stops*

The benchmark stops are the ones mentioned so far in the book. f4, f5.6, f8, f11, f16. 1/60th, 1/125th, 1/250th, 1/500th. ISO 100, 200, 400, 800. But you may find that your camera picks an aperture like f7.1, or a shutter speed of 1/160th. That's because there are stops that fall exactly half way between the benchmark full stops, and there are also stops that fall exactly a third and two thirds of the way between the benchmark full stops. Your camera will be set to

*Double the light / half the light*

As you move between stops, remember that each stop lets in *twice as much light* as the one before it (rather than just +1 stop). This diagram shows

speed scale. Knowing this allows you to compensate accurately.

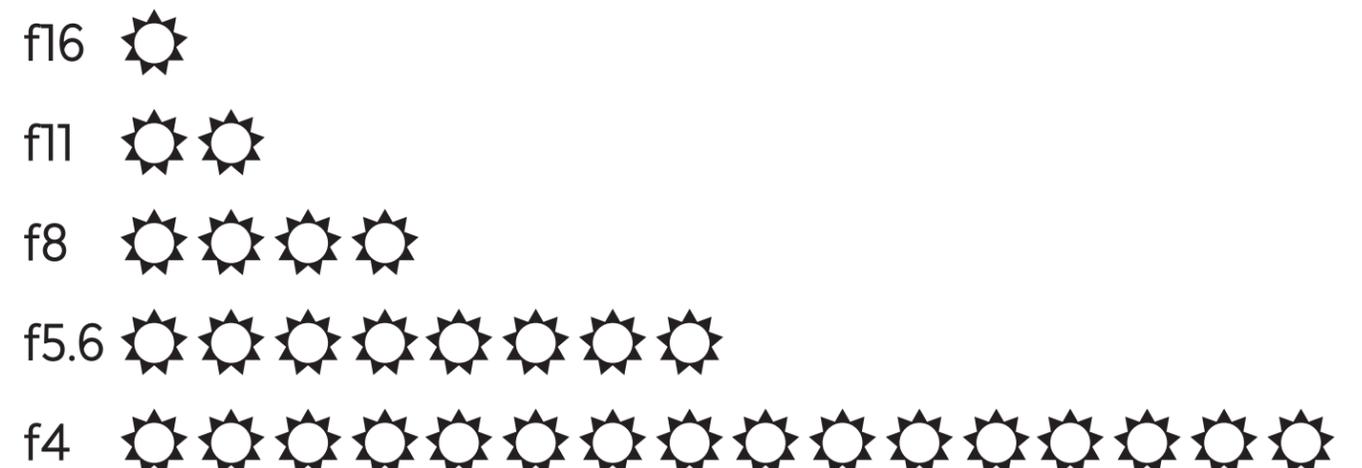
If the camera picked f5.6 but you want f11, that's 2 full stops smaller.  $f5.6 > f8 > f11$ . So, to keep the same exposure, you would need to change the shutter speed by 2 full stops larger, eg.  $1/500th < 1/250th < 1/125th$ . Or the ISO by 2 full stops larger;  $ISO\ 100 < ISO\ 200 < ISO\ 400$ . Or you could change the shutter speed by 1 full stop and the ISO by 1 full stop.

show either full plus half, or full plus third stops. You can change between them.

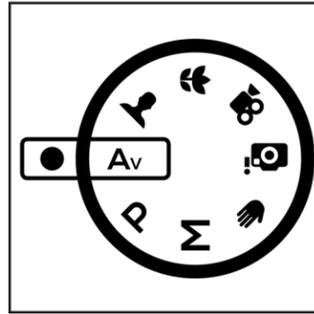
It's not critical that you remember all the half stops and third stops, but you should be familiar with the benchmark full stops for each of the 3 settings.

In Appendix 1 you'll find all the stops - full, half and thirds. Have a quick look now.

the concept for apertures, so you can see the huge difference between each end of the scale:



## Homework - shoot on Manual



**f8**  
**1/250**  
**ISO200**

**f8 > f5.6**

**1/250 >**  
**1/500**

1. Select aperture priority mode, choose an aperture that's a full stop (eg f8) and take a photo.

2. Write down what settings the camera picks. Your settings might be different to these.

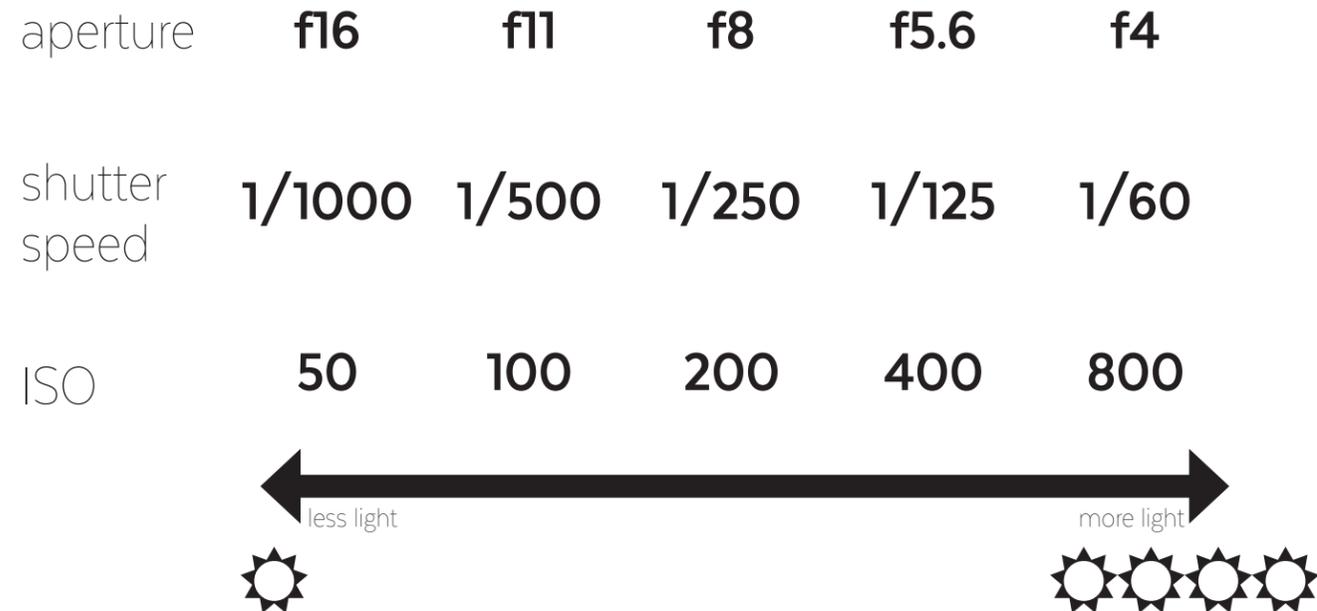
3. Go onto Manual mode and change the aperture by 1 stop (bigger) to have a shallower depth of field.

4. Change the shutter speed by a corresponding 1 stop in the opposite direction (faster) and take another photo.

Both the photos should have the same exposure, if the light hasn't changed and you focussed on the same spot. The only difference should be a slightly shallower depth of field in the second photo.

Have another go, this time on shutter priority. Try changing the settings by 2 stops, and by using a combination of both aperture and ISO to compensate.

This chart shows the 3 settings laid out in the same direction, from less light to more light (or for ISO, less sensitive to more sensitive), to help you with this exercise. It's important that you start on a full stop setting. Check Appendix 1 if your settings aren't shown here - you may be on a third or a half stop setting.



## TEST YOURSELF

This is a difficult test. Don't expect to get full marks on your first try, or for it to take only a minute or two. Have a go, move on, but come back to it from time to time. By the end of the year you should find it straightforward.

1. Which of these is the only full stop aperture?

A f7.1      B f5.6      C f3.5

2. Which of these are full stop shutter speeds?

A 1/60      B 1/125      C 1/400

3. To go one full stop faster (less light) from a shutter speed of 1/125, what do you need?

A 1/60      B 1/250      C 1/500

4. To go one full stop wider (more light) from an aperture of f5.6, what do you need?

A f8      B f16      C f4

5. To go 2 stops less light than f11, 1/250 and ISO 400, which combination can you use?

A f16, 1/125, ISO 400      B f11, 1/500, ISO 400      C f16, 1/250, ISO 200

6. To go 2 stops more light than f16, 1/500 and ISO 200, which combination can you use?

A f8, 1/125, ISO 100      B f8, 1/500, ISO 200      C f11, 1/1000, ISO 200

7. To go 3 stops less light than f8, 1/250 and ISO 200, which combination can you use?

A f5.6, 1/125, ISO 400      B f16, 1/60, ISO 100      C f8, 1/1000, ISO 100

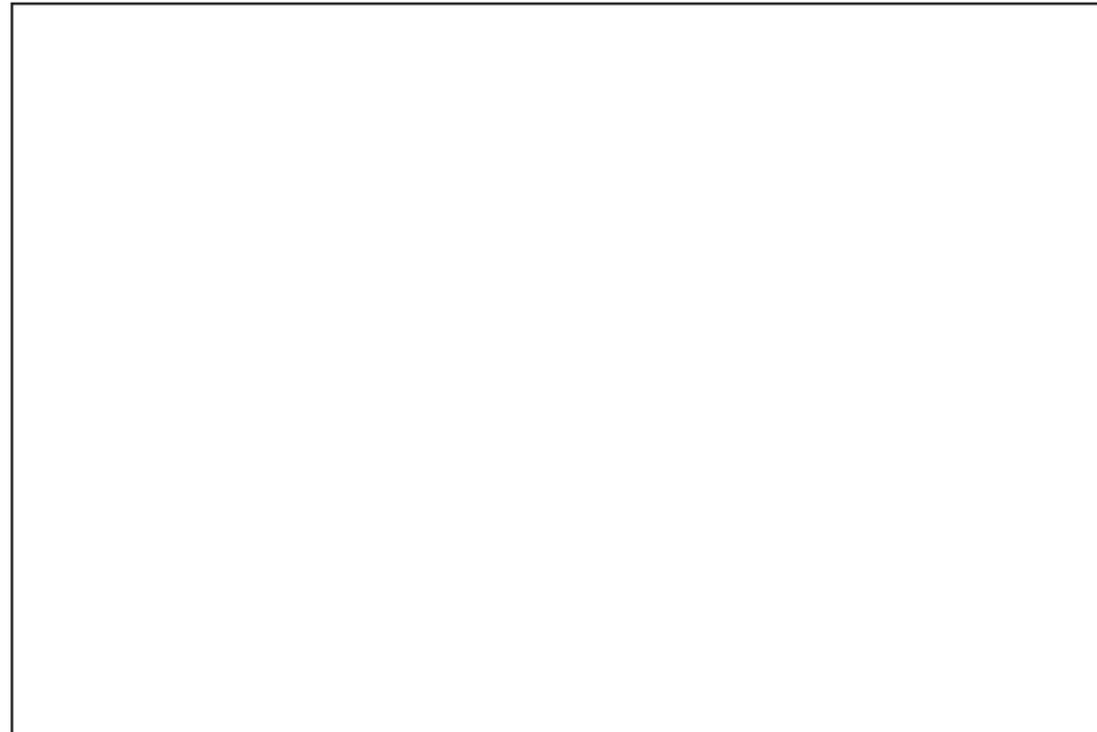
8. To go 3 stops more light than f11, 1/500 and ISO 100, which combination can you use?

A f4, 1/60, ISO 800      B f16, 1/1000, ISO 50      C f8, 1/250, ISO 200

1: B    2: A, B    3: B    4: C    5: C    6: B    7: C    8: C

ANSWERS

Stick one of your homework photos here:



*In my own words...*

Can you write down the full stops for aperture, shutter speed and ISO, in order from least light to most light?

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## Checklist for Chapter 5

- I know that this is one of the most difficult chapters, and that I don't need to learn it all off by heart today
- I understand that aperture, shutter speed and ISO are like 3 corners of a balanced triangle, and that if I change one, the other two need to change by an equal and opposite amount if I want to keep the same exposure
- I know that a stop of light is the amount between full increments of aperture, shutter speed and ISO
- I know that stops can be measured in full increments (like f5.6 and 1/60th), but also in half stops and third stops (see Appendix 1)
- I know that the easiest way to remember how the stops work together is to actually try to change them
- I have done the homework
- I have tried the quiz, but not felt a failure if it was really hard - I trust the fact that if I keep working through the course it will get easier

---

You don't need to understand everything about stops and shooting on Manual mode right now. If you can tick off everything in this checklist, you can move on.

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TO AVOID CRITICISM, DO  
NOTHING, SAY NOTHING, AND  
BE NOTHING

~ ELBERT HUBBARD



## 6: Metering

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The final piece of the puzzle

The question you will answer today, is this: "I know the camera gets the exposure wrong a lot (because it exposes for a mid grey tone). But how do I know what the right exposure is?"

---

### In this chapter

So far in Part 1 you have learnt that the camera wants to turn everything mid grey, which is a problem if your subject is on the white side or on the black side overall.

You have learnt how to manipulate each of the 3 settings (aperture, shutter speed and ISO).

And in the last chapter you learnt how to start with the settings the camera picked but then switch to Manual mode and change one or all of them separately, without changing the overall exposure.

In this chapter you will learn the final piece of information you need to be able to call yourself a photographer: how to tell what the right exposure

is in the first place. It's no good being able to change the settings on Manual mode if you are just preserving an incorrect exposure. You need to be able to first decide if the camera has got it right, and then decide what settings you want.

It's a lot to remember, but you don't have to be able to do it all by the end of the chapter. And you won't always be needing to shoot on Manual or correct the camera's exposure. For now, you only have to understand it, and have had a go. Throughout the rest of the course there will be plenty of reminders and exercises to keep you practising.

## What is metering?

When the camera measures how much light is falling on the scene, this is called metering. In the old days we used to use a light meter. We carefully picked a mid-grey part of the landscape, or took a reading off whatever we wanted to be correctly exposed (usually someone's face), and then translated the meter's suggested settings to suit our creative priorities.

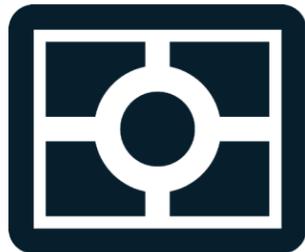
This is still the most accurate way to get the right exposure.

But 21st century cameras pretty much do away with the need to use light meters, unless you're working in a studio. Now you can rely on the camera's built-in light meter, plus the instant histogram feedback you get.

## How does the camera meter?

Just as it's critical that you know what the camera is programmed to do when it comes to fixing exposure (it turns everything mid-grey), so you also need to know what it has been programmed to do when it measures the light in first place (metering). There

are 3 kinds of metering that the camera can use, and you can switch between them (check your manual). In each one, the camera is programmed to do something different.



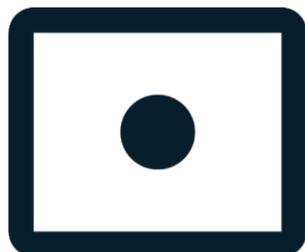
### 1. *Matrix, or evaluative metering*

This is usually the default setting. The camera takes a broad reading from everywhere in the frame. Useful for beginners, but if the background is light (like the sky), and your subject is just in the middle, the light background will skew the exposure and your subject will not be correctly exposed.



### 2. *Centre-weighted metering*

The camera gives priority to whatever is in the middle of the frame. This is a better all-purpose setting to use, if you generally want what is in the middle of the frame to be correctly exposed.



### 3: *Spot metering*

You pick one very small area of the frame to take a reading from, usually one of the small rectangles that you can see in the viewfinder that the camera uses to show where it has focussed. This is the most accurate way of getting a correct exposure for a single part of the image.

## Using the histogram

The histogram is a graph that shows the results of the camera's metering, in bar chart form. You can switch it on in your settings, so it will either show up in the viewfinder as you take your photo, or on the LCD as you review your photos afterwards.

This is where the magic happens. The one thing that is constant throughout all of this is the histogram. It never lies. The rest of what the camera is doing can be misleading: the exposure it makes is based off a mid-grey baseline which might not be accurate for your image. The metering will depend on which mode you have selected. You can't even rely on the LCD on your camera to be accurate because the brightness settings can be changed, and the appearance alters depending how bright or dark your surroundings are.

Don't forget your eye/brain combination also can mislead you. Your brain interprets what the eye sees and you can often think something is bright enough because it *should* be bright enough, and your eyes have got used to the dark.

You can use the histogram to check that what the camera is telling you is in fact what is in front of you. If you're taking a photo of a polar bear in the snow that is coming out grey, you can check the histogram to see what's going on. If you're taking a photo of a black dog in a black shed, you can check the histogram. And if you're just taking a photo of a sunset, a landscape, your grand-daughter or a flower, and it doesn't look quite right, you can check the histogram to see what you need to do to fix it.

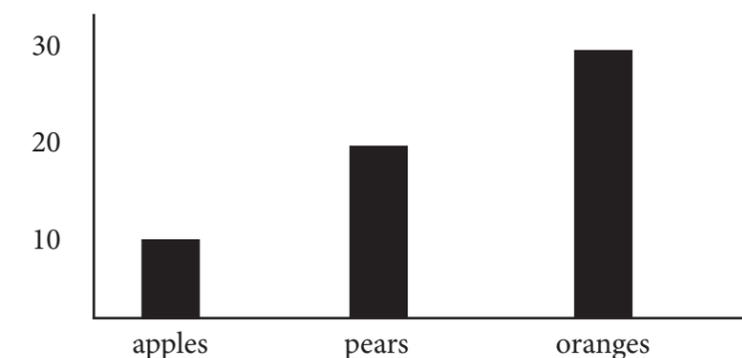
Here's how. First, check your manual and change the settings so that the histogram shows as a preview in your viewfinder or on your LCD when you take a photo (look up "LCD preview", or "viewfinder preferences"). Next, start to take a photo - half press the shutter to get the focus - and see what the histogram is doing.

Lastly, look at the scene and ask yourself whether the histogram reflects what you are seeing in front of your eyes. If not, you know the camera's auto settings or metering mode have defaulted to something you don't want. You can then correct the camera's error.

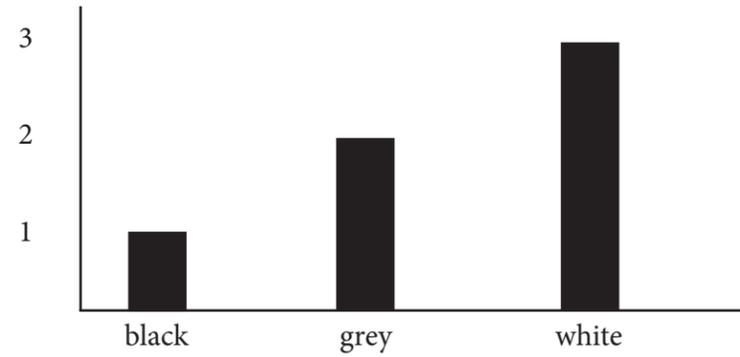
## What exactly is the histogram?

On the next couple of pages I'll show you how to do all this - how to interpret the histogram, check it reflects reality, and then fix anything that needs fixing. First, here's a quick explanation of what the histogram does.

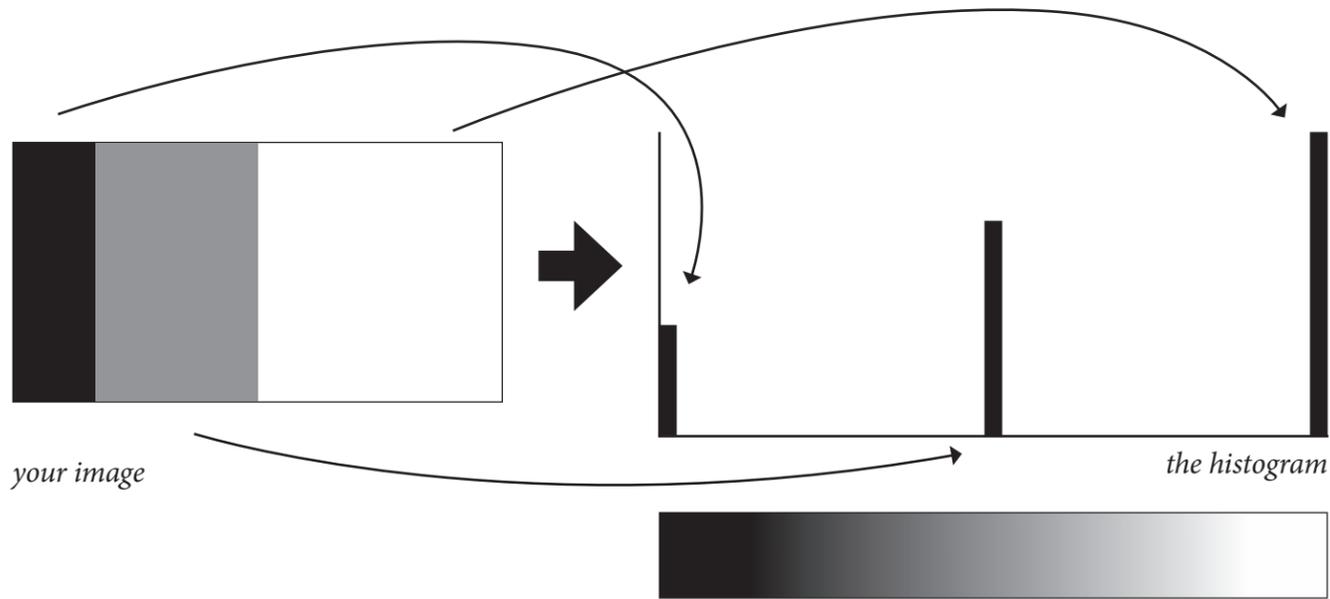
The histogram is simply a bar chart showing light values. Imagine a bar chart showing how many apples, pears and oranges a shop sells in a week. If it sells 10 apples, 20 pears and 30 oranges, the bar chart will look like this:



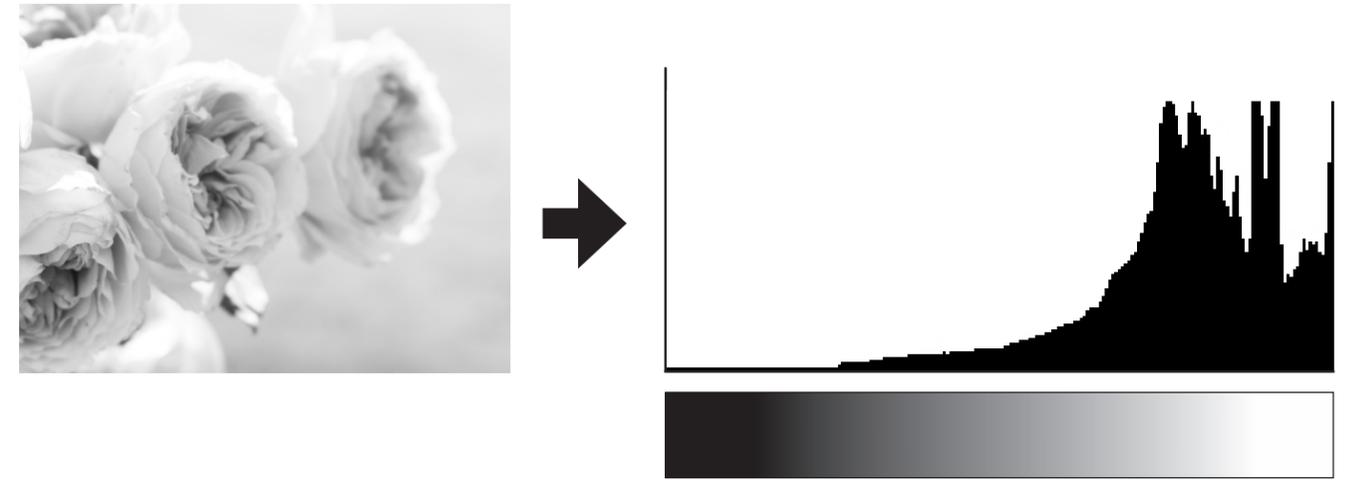
Now imagine you are looking piece of paper which has 1 black stripe, 2 grey stripes, and 3 white stripes. The bar chart would look like this:



And that is all the histogram does. The camera assigns a tone value (from black to white via all the greys) to every single pixel in your image. It then plots them on a bar chart to give you your histogram. It counts all the pure black pixels and gives them a bar all the way to the left, and does the same for every shade of grey all the way to pure white over on the right.



When it comes to an actual photograph, the camera just counts all the pixels, sees how many of each tone there are, and then plots them all on a bar chart:



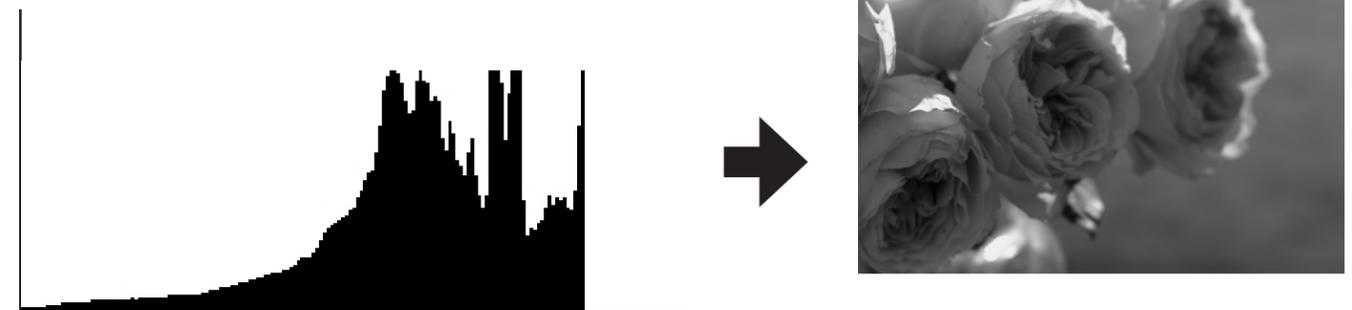
In this image the histogram is showing that there are no black and darker tones at all. Does that look right? In the original image you can still see plenty of detail in the shadows which means they are not completely black, so yes, you would not expect to see the histogram touching the left hand side of the chart.

And at the right hand side, the white bar chart has started to "climb the wall" - it finishes with plenty of white tones showing. This is a sign that the highlights have blown out, and lost all detail - you should be able to see areas of pure white somewhere in the image. Is that correct? Yes - some of the petal highlights are pure white.

### Using the histogram to check the exposure

If the histogram had looked like the following diagram, then you would know that the exposure the camera had picked was wrong. Because you can look at the histogram, see that the whites fall short of the right hand side of the chart, and then look at the scene and realise that you *should* have pure whites. You would deduce the camera has got the exposure wrong and you can correct it, in this case by increasing the exposure.

*This histogram represents an underexposed image, like this one:*

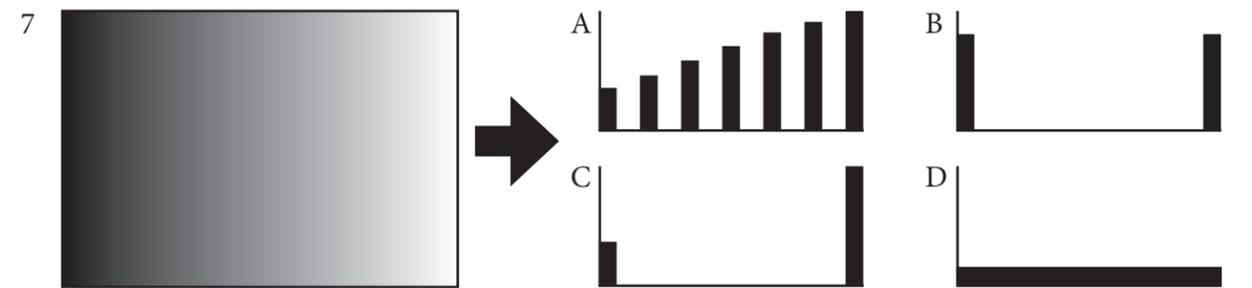
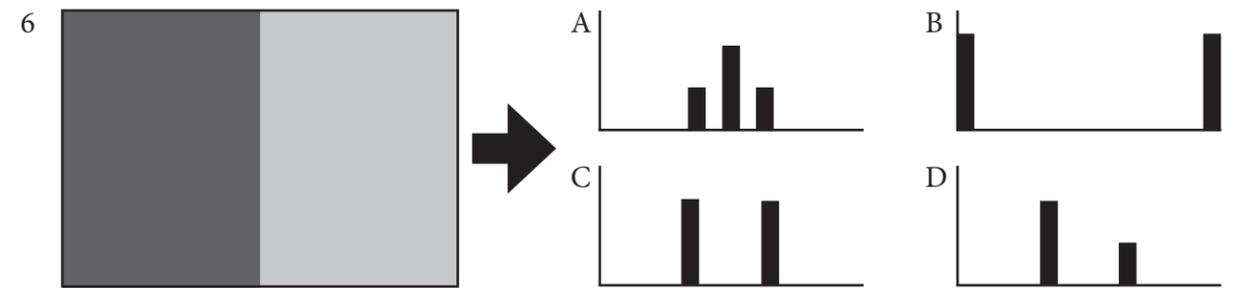
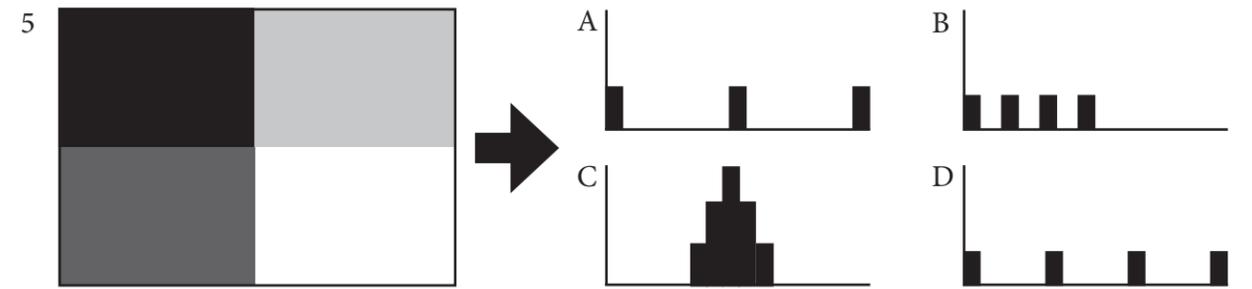
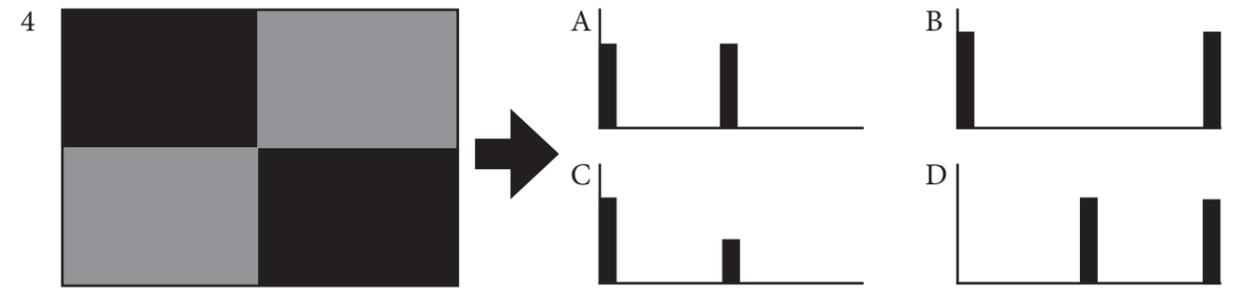
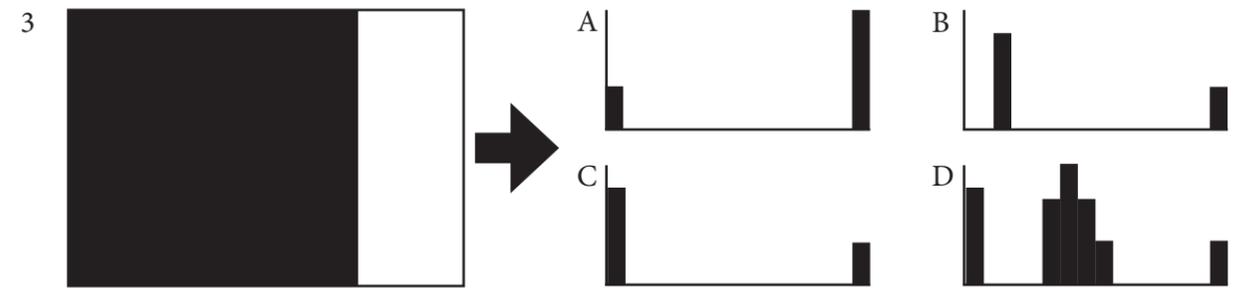
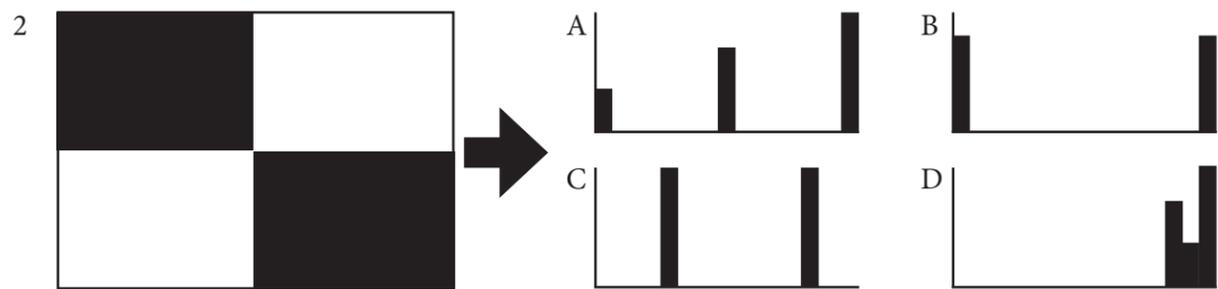
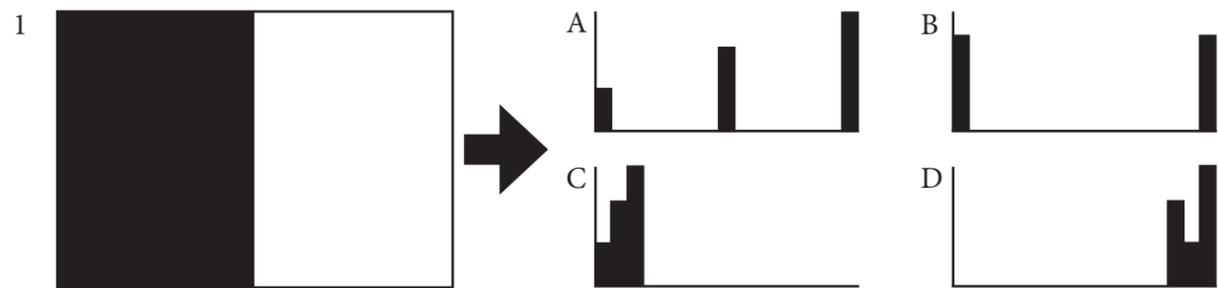


*A recap*

1. The camera's auto modes and LCD sometimes get the exposure wrong
2. Your eye/brain also sometimes gets things wrong
3. The histogram never gets anything wrong
4. You can see whether the exposure is correct by checking if the histogram looks like it should
5. If the histogram is not how it should be, you can compensate for the camera's mistake by changing aperture, shutter speed or ISO

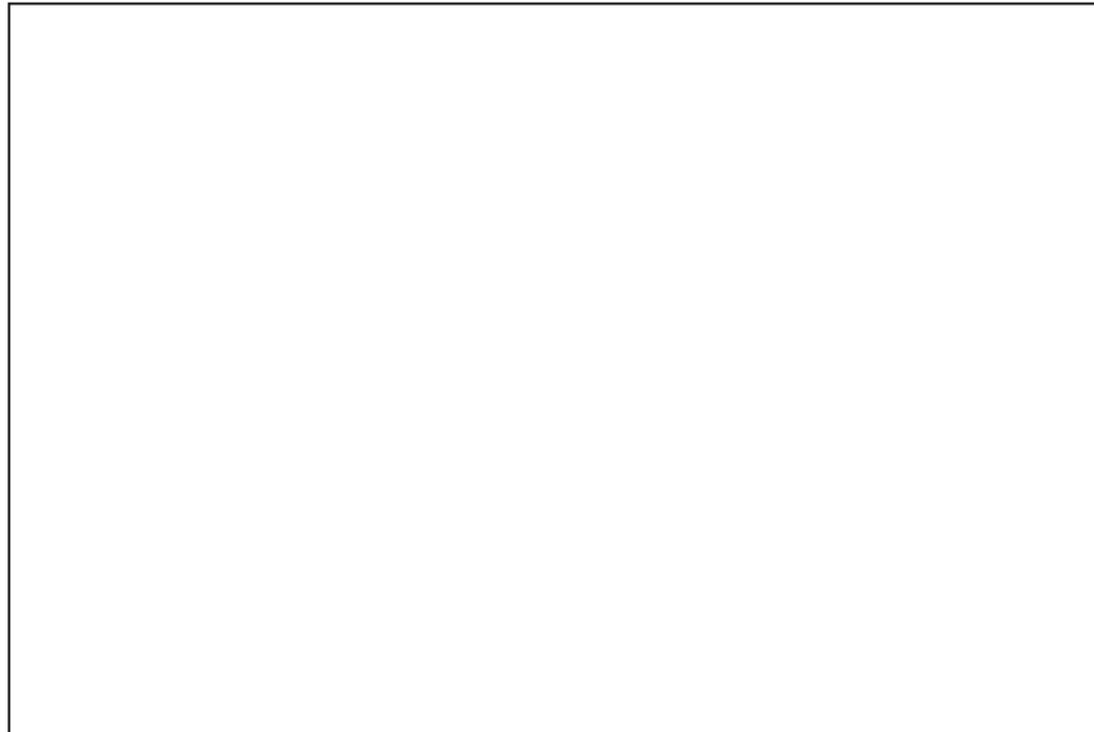
Well done for getting this far. Have a break, come back in 10 minutes.

The last step, compensating for the camera's mistakes, is the easy part. I'll cover that right at the end of the chapter, and you will be practising it for your homework. Before then, just check you understand histograms by having a go at this quiz. The image is on the left. Pick which of the 4 histograms represents the image. Answers and explanations on the following page.





Stick one of your homework photos here:



*In my own words...*

What do I understand now that I didn't before, about metering and histograms?  
What do I not really understand, and what is still entirely baffling?

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## Checklist for Chapter 6

- I understand that because the camera assumes everything should be a mid-grey tone, it often under or over exposes photographs
- I know that I can't rely on my camera's LCD to check if an image is correctly exposed because the brightness settings might be misleading
- I know that I can't rely on my eye/brain combination to tell me how dark or light a scene is because my eyes get used to very dark or very bright situations and my brain tells me they are neither dark nor bright
- I know that the histogram never lies
- I have worked out how to switch the histogram on in my viewfinder or on my LCD
- I have had a go at the quiz, but understand it's not important how many I got right: the important thing is that I read through the answers and explanations
- I have done the homework

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This is another complex chapter. You don't need to understand everything before you move on. Just be aware of the concepts of metering and histograms, and then come back later in the year to read it through again.

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## End of Part 1 - test yourself

Consolidate your knowledge by taking these photos:

- shot with my maximum aperture (biggest hole, smallest number)
- shot with my minimum aperture (smallest hole, biggest number)
- shot at f8
- shutter speed of 1 second
- shutter speed of 1/1000th second
- shot with my largest ISO
- small depth of field
- large depth of field
- creative camera shake
- subject in focus, background blurred
- background in focus, subject blurred
- everything in focus
- moving subject frozen
- moving subject blurred
- shot at minimum focus distance and maximum aperture
- shot at minimum focus distance and minimum aperture

## End of Part 1 projects

These are 2 bigger projects, which will ensure you understand all the controls on your camera, and how to expose correctly:

### PROJECT 1: depth of field study

Set up a chess board and pieces (or a collection of similar sized things, in a line that starts near the camera and ends farther away from the camera - not a line that starts to the left and finishes on the right). Take a series of images using each of your apertures in turn. Focus on the same chess piece each time (one in the middle), and see what happens to the depth of field.

### PROJECT 2: white on white study

Take a photo of something white, on a white background. Take care to get the exposure correct, so the image doesn't turn out grey. Keep enough detail in the shadows that you can see what the subject is.

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Don't forget to join the Facebook group (go to [AYearWithMyCamera.com/join-facebook](https://www.facebook.com/AYearWithMyCamera.com/join-facebook)) to ask questions, share your photos (if you want to) and meet other people doing the course. If you are on Instagram, use the hashtag [#AYearWithMyCamera](https://www.instagram.com/AYearWithMyCamera) to share your photos.

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