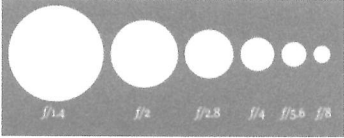


EXPOSURE

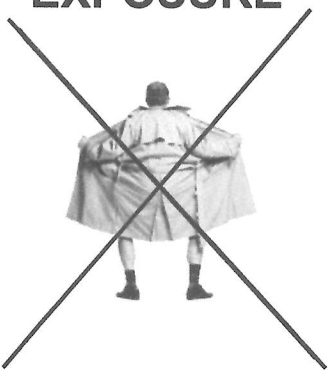


by Clem Wehner

1




EXPOSURE



2

Which photo is correctly exposed?



4

TOPICS


- Exposure
- Aperture
- f/stop
- Focal length
- Shutter speed
- ISO
- f/stop, shutter speed, and light
- f/stop & shutter speed changes
- Exposure equivalence
- Using settings in the real world
- Solving exposure problems

5

EXPOSURE

THE AMOUNT OF LIGHT
FALLING ON THE CAMERA'S SENSOR

NOT TOO DARK, NOT TOO BRIGHT



3

WHAT AFFECTS EXPOSURE?

1. f/stop
2. APERTURE
3. FOCAL LENGTH
4. SHUTTER SPEED
5. ISO

6

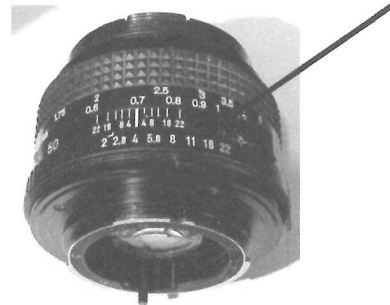
WHAT AFFECTS EXPOSURE?

1. f/stop
2. APERTURE
3. FOCAL LENGTH
4. SHUTTER SPEED
5. ISO

7

APERTURE- DIAMETER OF THE LENS OPENING

Affected by setting of the f/stop: (e.g. f/2, f/4, f/5.6, f/8, etc)

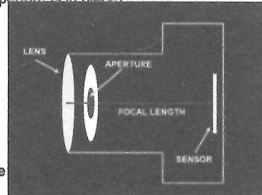


10

TERMS

Focal length- distance from the lens to the image that is formed. (Distance depends on the thickness and shape of the lens. Thicker glass & more curvature = shorter focal length)

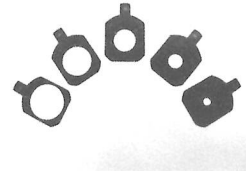
Aperture- diameter of the lens opening or the whole lens if no adjustable aperture is in place)



8

WHY IS IT CALLED "STOP"?

Waterhouse Stops



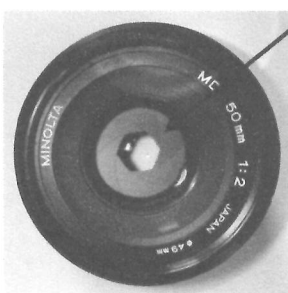
stops light



Invented by John Waterhouse in 1850s

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APERTURE- DIAMETER OF THE LENS OPENING



LARGER APERTURE = MORE LIGHT COMES IN

9

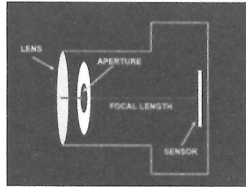
Why is it called
f/stop ?

It's a formula!

12

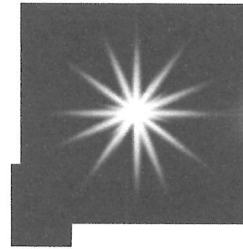
f/stop

f = focal length
divided by
 $stop$ = aperture diameter

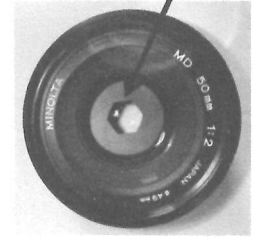


13

f/stop – how bright?



Aperture - what size?



16

f/stop

Focal length divided by **Stop (Aperture)**

Focal length aperture = f/stop
Example: 100mm / 50 mm = f/2
100mm / 25 mm = f/4
50mm / 25 mm = ?

14 f/stop is the brightness of the light

f/stop

Focal length divided by **Aperture (Stop)**

Focal length Aperture f/stop
Example: 100 mm / 50 mm = f/2
50 mm / 25 mm = f/2
80 mm / 40 mm = f/2

17 f/stop is a brightness of light

f/stop

is not the same as aperture!

Though, f/stop does affect the aperture

15

What setting f/stop actually does

- It is a REQUEST to the camera to let in a certain brightness of light.
- The camera/lens mechanism adjusts the aperture size, given the zoom focal length, to meet the photographer's requested brightness (f/stop).

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The Process of Taking a Photo

1. Set f/stop (brightness of light) wanted. (request)

$$f/\text{stop} = f / \text{stop}$$

2. Then set zoom to the focal length wanted

3. The camera adjusts aperture diameter (stop)

to achieve the requested f/stop (brightness of light), given the focal length that we selected by zooming.

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QUESTION

f/stop is affected by both aperture and focal length and zooming in reduces the light falling on the sensor.

So, why do we NOT have to adjust the f/stop when we zoom in?

ANSWER: Because the camera adjusts the aperture to achieve the desired f/stop

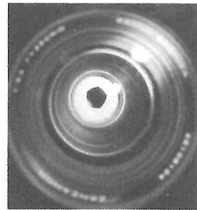
22

APERTURE VARIES WITH FOCAL LENGTH (ZOOM) AT THE SAME F/STOP

75mm zoom at f/16



300mm zoom at f/16



20

Longer focal length = dimmer image

It seems like setting f/stop is just setting aperture. It's much more than that!

But, it's convenient to think of setting f/stop as setting aperture

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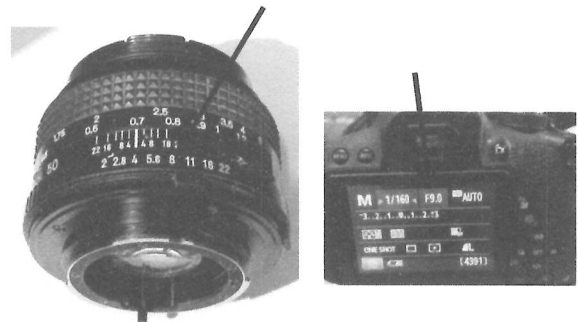
QUESTION

f/stop is affected by both aperture and focal length and zooming in reduces the light falling on the sensor.

So, why do we NOT have to adjust the f/stop when we zoom in?

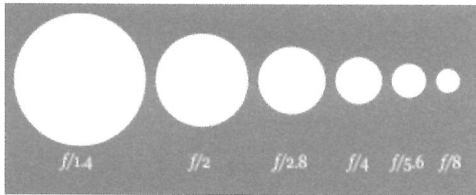
21

How to set f/stop



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How f/stop affects aperture



Small f/stop = more light

Large f/stop = less light

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Depth of Field



BLURRY, THEN CLEAR, THEN BLURRY
(varies with f/stop)

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WHAT HAPPENS WHEN

f/stop

changes?

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TIP THINK IN TERMS OF WHAT F/STOP DOES
(not what the opening size is)

Small f/stop number = Small Depth of Field

(f/1.4, f/2.8, f/4.0)



Large f/stop number = Large Depth of Field

(f/11, f/16, f/22)



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f/stop affects the size of aperture
and **size of the aperture affects:**

1. Exposure- the brightness of the light



2. Depth of Field- the in-focus part of image



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Remember → **Changing f/stop**

will also affect

Depth of Field

(especially at f/4 and less)

30

HOW MUCH DOES LIGHT CHANGE WHEN

f/stop

changes?

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WHAT AFFECTS EXPOSURE?

1. f/STOP
2. APERTURE
3. FOCAL LENGTH
4. SHUTTER SPEED
5. ISO

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EFFECT OF f/stop CHANGES ON LIGHT

A ONE f/stop CHANGE
DOUBLES OR HALVES THE LIGHT COMING IN

	BIG APERTURE				SMALL APERTURE				
f/stops:	2.0	2.8	4	5.6	8	11	16	22	
	More light comes in				Less light comes in				



But, only with main f/stops

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SHUTTER SPEED

THE AMOUNT OF TIME THE SHUTTER IS OPEN

LONGER TIME = MORE LIGHT

The sensor accumulates light!

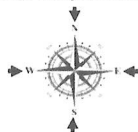
The longer the shutter is open, the more light (photons) accumulates on the sensor making the image brighter.

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The Main f/stops

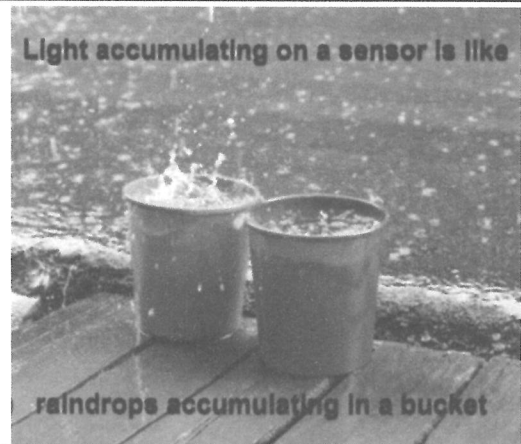
	BIG APERTURE				SMALL APERTURE							
f/stops:	1.0	1.4	2.0	2.8	4.0	5.6	8.0	11	16	22	-->	
	More light comes in				Less light comes in							

The Main Compass Directions



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Light accumulating on a sensor is like



raindrops accumulating in a bucket

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SHUTTER SPEEDS (seconds or fractions of a second)

1/2 1/4 1/8 1/15 1/30 1/60 1/125 1/250 1/500 1/1000
 SLOW SPEED FAST SPEED

Which is shorter: 1/8th or 1/30th second?

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Exposure Relationships

Remember → “ OPPOSITES ”

F/STOP - lower f/stop = more light
 ↓

SHUTTER - slower speed = more light
 ↓

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WHAT HAPPENS WHEN
SHUTTER SPEED
 changes?

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WHAT AFFECTS EXPOSURE?

1. f/STOP
2. APERTURE
3. FOCAL LENGTH
4. SHUTTER SPEED
5. ISO

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EFFECT OF SHUTTER SPEED CHANGES

**ONE shutter speed CHANGE
 DOUBLES OR HALVES THE BRIGHTNESS**

- Half the speed (ex: 1/60 to 1/30) = double the brightness
- Double the speed (ex: 1/60 to 125) = half the brightness

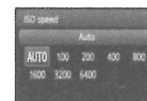
shutter: 1/8 1/15 1/30 1/60 1/125 1/250
 SLOW SPEED FAST SPEED

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ISO Setting

Adjusts the sensitivity of the sensor to light

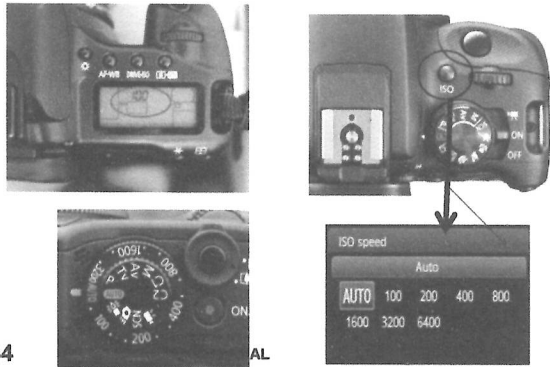
- Higher ISO = Higher sensitivity = brighter image
- Lower ISO = Lower sensitivity = dimmer image



NOTE: ISO can be changed for each photo

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Setting ISO



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Interim Summary

- EXPOSURE depends on:
f/STOP
FOCAL LENGTH
APERTURE
SHUTTER SPEED
ISO
- CHANGES: 1- f/stop, 1- shutter speed, or 1- ISO
 = double or half the light

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ISO Relationships

Each increment doubles or halves the sensitivity

ISO 100 –
 ISO 200 –
 ISO 400 –
 ISO 800 –
 ISO 1600 –
 ISO 3200 –

The higher the ISO, the brighter the image

Example: ISO 200 is twice brighter than ISO 100

45

Interim Summary

Remembering Exposure Relationships

OPPOSITE:

F/STOP ---- Opposite (lower f/stop= more light)

SHUTTER--- Opposite (slower speed= more light)

SAME:

ISO ----- Same - (lower ISO= less light)

DEPTH OF FIELD- Same- (lower f/stop= less DOF)

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Which controls to use first when adjusting exposure

1. f/stop
2. Shutter Speed
3. ISO setting

— last resort

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Using exposure information in real life



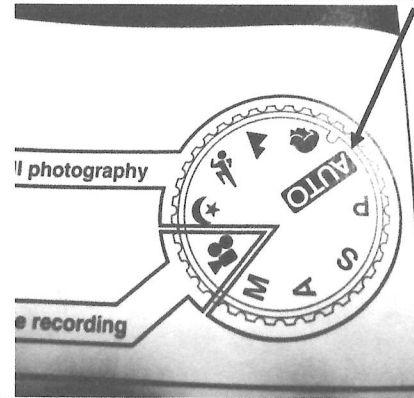
49

METHODS FOR SETTING EXPOSURE

1. Shoot in **AUTO EXPOSURE**
2. Shoot in **MANUAL** exposure mode. Use a handheld light meter and set the exposure settings yourself
3. Shoot in **MANUAL** exposure mode. Estimate the exposure and set the exposure settings yourself

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AUTOMATIC EXPOSURE MODE



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METHODS FOR SETTING EXPOSURE

1. Shoot in **AUTO EXPOSURE**
2. Shoot in **MANUAL** exposure mode. Use a handheld light meter and set the exposure settings yourself
3. Shoot in **MANUAL** exposure mode. Estimate the exposure and set the exposure settings yourself

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Auto mode uses the camera's built-in Light Meter

- ALL digital cameras have a built-in light meter.



- They are **REFLECTED** light meters only!
- Will **NOT** measure incident (direct) light.
- Very prone to erroneous readings!

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Why camera light meter may be wrong

PROBLEM #1:

- Camera's light meter averages the light in the scene.
- Your subject may not be in average light
- Subject will be "improperly" exposed in the photo


SUBJECT



55

In-camera light meters

PROBLEM #2

- To expose properly, camera expects a scene of medium (18%) gray tone (on average). 
- If the scene is too light in tone, camera will underexpose.



REAL WORLD- brighter than medium gray

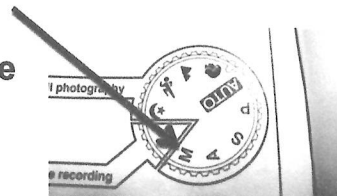


RESULTING IMAGE

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MANUAL EXPOSURE

Auto exposure is turned off



You decide:

f/STOP

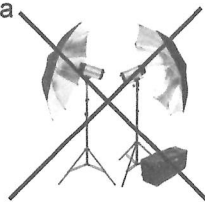
SHUTTER SPEED

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In-camera light meters

PROBLEM #3

- A camera's internal light meter cannot measure light from a flash unit.
- So, it can't be used to set camera exposure for studio lighting.



you must use a "FLASH" LIGHT METER

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How do I know what to set in?

60

METHODS FOR SETTING EXPOSURE

1. Shoot in **AUTO EXPOSURE**
2. Shoot in **MANUAL** exposure mode. Use a handheld light meter and set the exposure settings yourself
3. Shoot in **MANUAL** exposure mode. Estimate the exposure and set the exposure settings yourself

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USE A LIGHT METER

To determine:

SHUTTER SPEED and **f/stop**

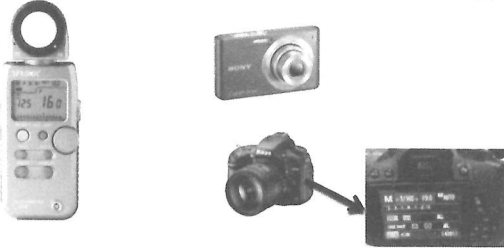


61

Light Meter

Measures the brightness of light

Handheld or internal (auto mode only)



62

SUNNY 16 RULE

Set shutter speed to the ISO setting
Then f/stop will be:

- f/16 BRIGHT SUN
- f/11 SLIGHT OVERCAST
- f/8 OVERCAST
- f/5.6 HEAVY OVERCAST
- f/4 OPEN SHADE / SUNSET

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METHODS FOR SETTING EXPOSURE

1. Shoot in AUTO EXPOSURE
2. Shoot in MANUAL exposure mode. Use a handheld light meter and set the exposure settings yourself
3. Shoot in MANUAL exposure mode. Estimate the exposure and set the exposure settings yourself

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What do I change if
the settings I use
aren't right?

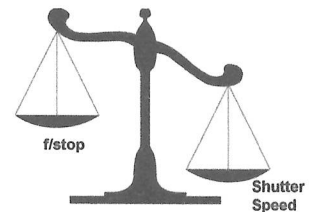
66

How do I estimate exposure settings?



64

Exposure Equivalence



67

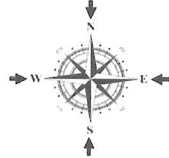
The Main f/stops

BIG APERTURE SMALL APERTURE

f/stops: 1.0 1.4 2.0 2.8 4.0 5.6 8.0 11 16 22 -->

More light comes in Less light comes in

The Main Compass Directions



68

This is the same exposure as 1/60 and f/8

BIG APERTURE SMALL APERTURE

f/stops: 2.0 2.8 4 5.6 8 11 16 22

shutter: 1/8 1/15 1/30 1/60 1/125 1/250

SLOW SPEED FAST SPEED

f/5.6 and 1/125th is the same exposure as f/8 and 1/60th

71

Determining Equivalent Exposure

BIG APERTURE SMALL APERTURE

f/stops: 2.0 2.8 4 5.6 8 11 16 22

shutter: 1/8 1/15 1/30 1/60 1/125 1/250

SLOW SPEED FAST SPEED

Example: You are taking photos of a flower and determine f/8 and 1/60th is a good exposure.

69

Getting Equivalent Exposure Values

If you change f/stop or shutter speed in one direction then change the other in the opposite direction and by the same amount of change

e.g. Up 1 shutter speed, then go down 1 f/stop
Up 2 f/stops, then down 2 shutter speeds

72

What's the right f/stop?

BIG APERTURE SMALL APERTURE

f/stops: 2.0 2.8 4 5.6 8 11 16 22

shutter: 1/8 1/15 1/30 1/60 1/125 1/250

SLOW SPEED FAST SPEED

If increasing shutter speed:

But, the image is blurry because the flower is blowing in the wind. So your increase the shutter speed to 1/125th second. What's the new f/stop?

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Determining Equivalent Exposure

BIG APERTURE SMALL APERTURE

f/stops: 2.0 2.8 4 5.6 8 11 16 22

shutter: 1/8 1/15 1/30 1/60 1/125 1/250

SLOW SPEED FAST SPEED

Example: You are photographing moving water. f/8 and 1/60th is a good exposure, but you want the water to be more silky. You slow the shutter to 1/30th. What's the new f/stop?

73

This is the same exposure as 1/60 and f/8

	BIG APERTURE				SMALL APERTURE			
f/stops:	2.0	2.8	4	5.6	8	11	16	22
shutter:	1/8	1/15	1/30	1/60	1/125	1/250		
	SLOW SPEED				FAST SPEED			

f/11 and 1/30th is the same exposure as f/8 and 1/60th

74

Getting Equivalent Exposures

If you go UP on one ↑
then go DOWN on the other ↓
(by the same amount of change)

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Determining Equivalent Exposure

	BIG APERTURE				SMALL APERTURE			
f/stops:	2.0	2.8	4	5.6	8	11	16	22
shutter:	1/8	1/15	1/30	1/60	1/125	1/250		
	SLOW SPEED				FAST SPEED			

What's the right shutter speed?

Example: you shoot a portrait at f/8 at 1/60th and get a good exposure. You lower the f/stop to f/4 to get a softer background. What's the new shutter speed?

75

REMEMBER

You must use the main f/stops (not intermediate f/stops)

f/stops: 2.0 2.8 4.0 5.6 8.0 11 16 22

But, you can use any shutter speed

Shutter: 1/4 1/8 1/15 1/30 1/60 1/125 1/250

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This is the same exposure as 1/60 and f/8

	BIG APERTURE				SMALL APERTURE			
f/stops:	2.0	2.8	4	5.6	8	11	16	22
shutter:	1/8	1/15	1/30	1/60	1/125	1/250		
	SLOW SPEED				FAST SPEED			

f/4 and 1/250th is the same exposure as f/8 and 1/60th

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The Emailed Questions

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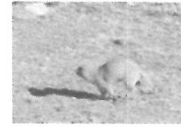


It's clear day in the Refuge and the Prairie Dogs are out.

You set your camera to shutter speed 1/100th and ISO 100 for best image quality.

What should the f/stop be?

80



You decide to photograph a Prairie Dog running. You set 1/100 and f/16. It is perfectly exposed, but the Prairie Dog is blurred.

You decide you need a higher shutter speed to stop the action. So you raise it to 1/200th.

**Answer: shutter = 1/200th
f/stop = f/11**

f/stops: 2.0 2.8 4 5.6 8 11 16 22

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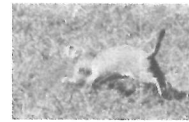


It's clear day in the Refuge and the Prairie Dogs are out.

You set your camera to shutter speed 1/100th and ISO 100 for best image quality.

**Answer: shutter = 1/100th
f/stop = f/16**

81



You were using 1/200 and f/11. But, the clouds roll in and the sky becomes lightly overcast.

You decide to photograph another Prairie Dog running across the field.

What should the f/stop be?

f/stops: 2.0 2.8 4 5.6 8 11 16 22

84



You decide to photograph a Prairie Dog running. You set 1/100 and f/16. It is perfectly exposed, but the Prairie Dog is blurred.

You decide you need a higher shutter speed to stop the action. So you raise it to 1/200th.

What should the f/stop be?

f/stops: 2.0 2.8 4 5.6 8 11 16 22

82

SUNNY 16 RULE

Set shutter speed to the ISO setting
Then f/stop will be:

- f/16 BRIGHT SUN
- f/11 SLIGHT OVERCAST
- f/8 OVERCAST
- f/5.6 HEAVY OVERCAST
- f/4 OPEN SHADE / SUNSET

85



You were using 1/200 and f/11. But, the clouds roll in and the sky becomes lightly overcast.

You decide to photograph another Prairie Dog running across the field.

**Answer: shutter = 1/200th
f/stop = f/8**

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FLASH: Set f/stop to tell it how bright to make the light on the subject. Higher f/stop is brighter.



CAMERA: Set f/stop to adjust the amount of light on the sensor to match the light on the subject.



Example:

Flash is set to f/8. It lights the subject to f/8 brightness

If camera is set to f/8 - properly exposed image
If camera is set to f/4 - over exposed image

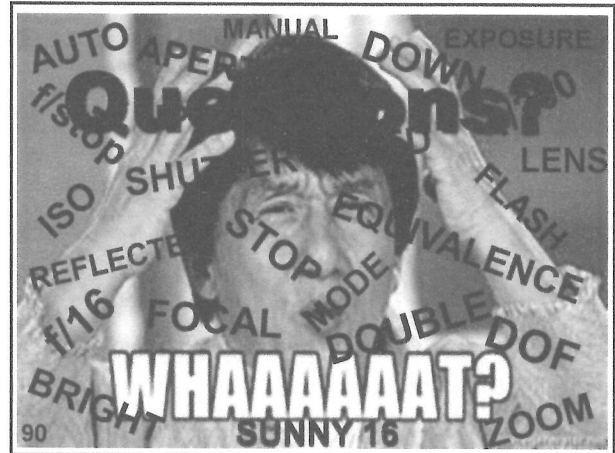
89

Go practice!



It will quickly become second nature.

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ONE LAST QUESTION

Why is it that we dial in a higher f/stop into a flash unit to make the light brighter?



but, we dial in a lower f/stop in a camera to make the image brighter.



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