



Aperture & f/stop Worksheet

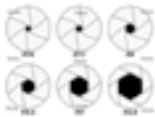
Manipulating Depth-of-Field



The aperture setting (AV on the dial) is a setting to control the amount of light which reaches the camera's SD card.



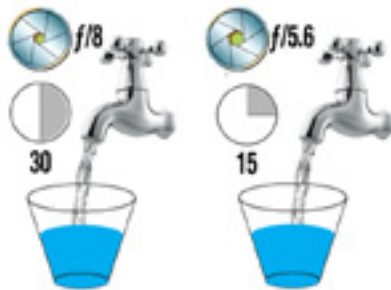
It is an adjustable opening inside the back of camera lens working similar to the iris in your eye.



The size of the opening regulates how much light passes through the lens to hit the sensor.



The larger the opening the more light is allowed through. The smaller the opening the less light is allowed through.



- ▶ The time the more light is allowed through.
- ▶ The smaller the time the less light is allowed through.
- ▶ The larger the opening the more light is allowed through.
- ▶ The smaller the opening the less light is allowed through.
- ▶ Notice the time & f/stop differences result in equal amounts.

Targets:

1. Know and be able to use the mathematical series for apertures known as *f/stops*.
2. Be able to predict the next *f/stop* in the series.
3. Be able to explain the relationship between *f/stops* and the size of an aperture.
4. Explain the relationship between shutter speed and aperture.
5. Use exposure compensations to correct changes in *f/stop*.
6. Use *f/stops* to control depth-of-field.
7. Create images showing shallow and deep depth-of-field.
8. Demonstrate the relationship between depth-of-field and aperture.

Breaking Down the Chart

1. Aperture settings are referred to as *f/stops*.
2. $f/stop = \text{focal length} \div \text{aperture diameter}$
3. The **smaller** the number (*f/2.8*) the **larger** the opening (more light and less in focus)
4. The **larger** the number (*f/22*) the **smaller** the opening (less light and more in focus)
5. An aperture of *f/2.8* will let in twice as much light as an aperture setting of *f/4*.
6. As the numbers get **bigger** the **less** light gets in.
7. Each change in *f/stop* will double or half the amount of light.
8. The increase from one *f/stop* to the next is times $\sqrt{2}$. The decrease is it divided by $\sqrt{2}$.
9. The *f/number* (stop) alternately doubles or halves.

www.photoplusmag.com

Making sense of f/stops

At-a-glance guide to aperture scales, and what the settings mean

	Full stops	1/2 stops	1/3rd stops
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/2.8	2.8	2.8
		3.5	3.2
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/4	4	3.5
		4.5	4
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/5.6	5.6	4.5
		6.7	5
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/8	8	5.6
		9.5	6.3
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/11	11	7.1
		13	8
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/16	16	9
		19	10
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD	1/22	22	11
			13
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD			16
			19
↑ MORE LIGHT ↑ MORE DEPTH OF FIELD			22
			25

Wide apertures
The widest apertures have the *f/stops* with the smallest numbers. The widest "maximum" aperture available depends on the lens you are using. On many zooms, the maximum aperture gets smaller as you zoom in.

Mid apertures
The middle apertures on your lens tend to give you the best quality images – although they may not give you the amount of depth of field you require.

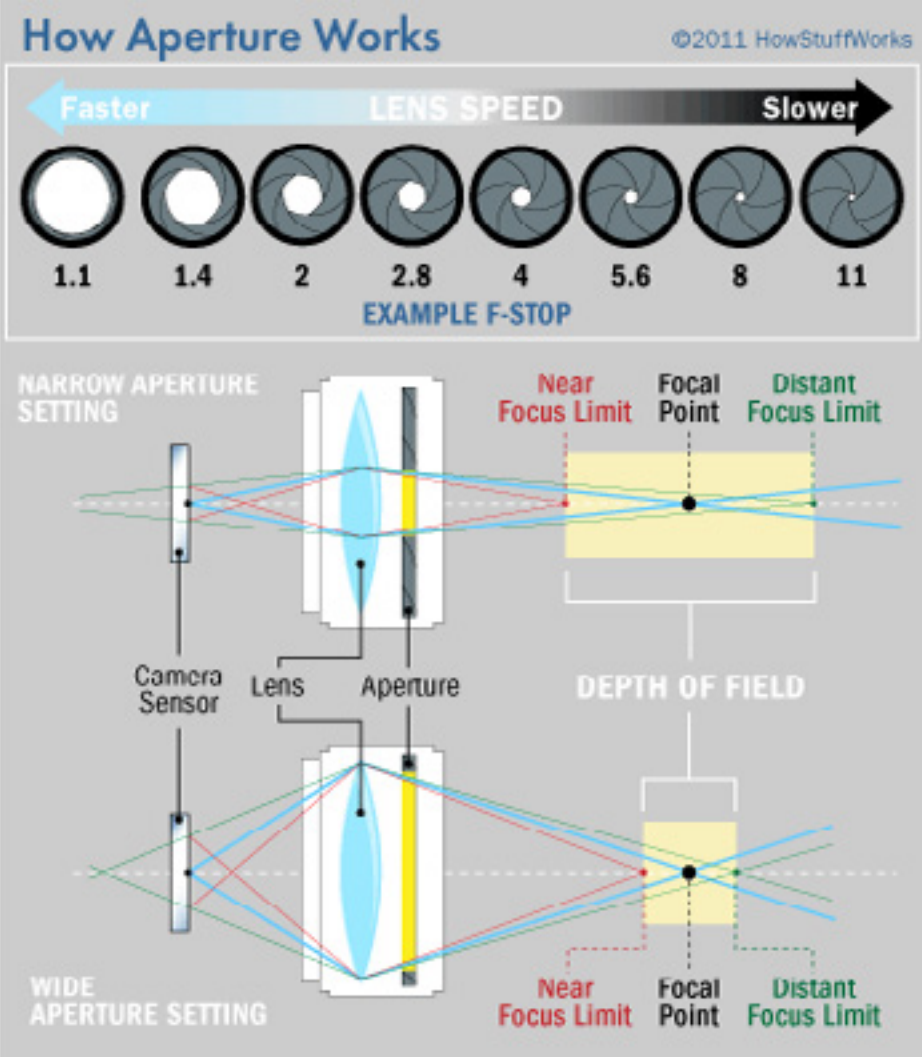
Small apertures
Most lenses have a minimum aperture of *f/22*, although some may offer smaller settings of, say, *f/25* or *f/32*. As the aperture gets smaller the more depth of field you get, but image resolution deteriorates due to a phenomenon called diffraction.

Name: _____

Period: _____ Date: _____

Photography Vocabulary

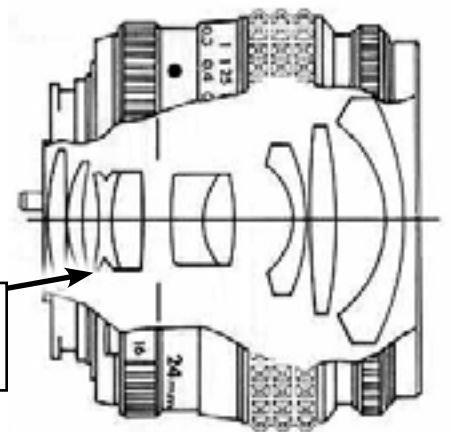
Term	Definition
Aperture	As it pertains to photography
Bracketing	As it pertains to exposure
Circle(s) of confusion	As it pertains to photography
Depth-of-field	As it pertains to photography
Depth-of-Field Preview	As it pertains to photography
<i>f</i> /stop	As it pertains to photography, Include formula
Focal Length	As it pertains to photography
Hyperfocal Distance	As it pertains to photography
Infinity	As it pertains to photography Include symbol
Lens Speed	As it pertains to photography, as it relates to exposure
Reciprocity	As it pertains to exposure
Selective Focus	As it pertains to photography
Stop	As it pertains to photography



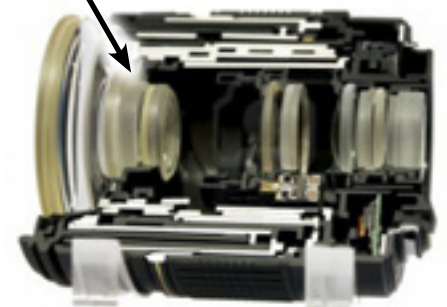
Aperture Mount
from Canon 50mm f/1.8 lens



24mm Lens Cutaway



Zoom Lens Cutaway



Lens Speed

Fast Lenses

Fast lenses have large aperture openings. They let in more light which allows for faster shutter speeds. This is why they are called fast lenses. A fast lens would have a f /stop range of $f/1.4$ for a 55mm lens (normal) to $f/2.8$ for a longer lens.

Most photographers prefer faster lenses as they let in more light allowing for faster shutter speeds and lower ISO settings. Because larger diameter glass lenses must be used and more care given in mounting these lenses they are more expensive.

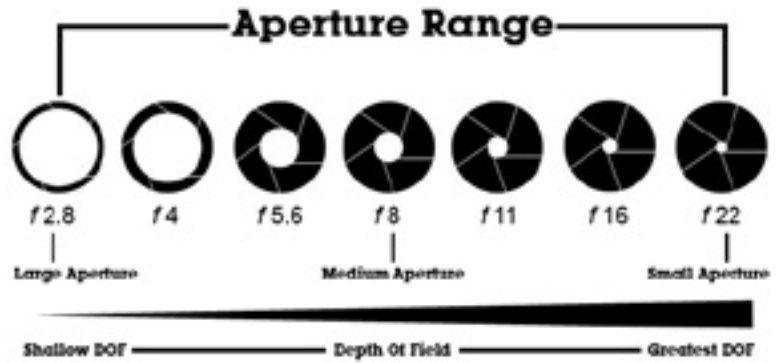
Slow Lenses

Most zoom lenses (lenses with a variable focal length) are slower lenses as they have smaller aperture openings ($f/4-5.6$) because of the number of glass lenses and the amount which each lens is covered by its mounting.

Name: _____

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Standard
Aperture & f/stop
Settings



Reciprocity

When you keep the exposure **the same** (equal amount of light reaches film) in all photos.

Where 1 stop of light equals 1 change in...

- a. shutter speed
- b. f/stop (aperture)
- c. ISO (sensor sensitivity)*

If you change your shutter speed, then you must change your f/stop.

If you change your f/stop, then you must change your shutter speed.

* ISO changes are usually only made as last resort (keep them low because of noise).

Same

Bracketing

When you purposefully **change the exposure** so each photo has a **different exposure** (+2, +1, N, -1, -2) making some photos over exposed (no details in highlights) and others under exposed (no details in shadows).

Change only one, either...

- a. the shutter speed (or)
- b. the f/stop (aperture)

Different

Shutter Speed & f/stop Chart

<p>➡➡➡➡➡ More Light ➡➡➡➡➡</p>														
Shutter Speeds														
2000	1000	500	250	125	60	30	15	8	4	2	1s	B	2s	4s
f/stops (aperture)														
64	44	32	22	16	11	8	5.6	4	2.8	2	1.4			
<p>⬅️⬅️⬅️⬅️⬅️ Less Light ⬅️⬅️⬅️⬅️⬅️</p>														

Name: _____

Period: _____ Date: _____

Complete the Equations

$$f/1 \quad * \quad \sqrt{2} \quad = \quad f/1.4$$

$$f/1.4 \quad * \quad \sqrt{2} \quad = \quad f/2$$

$$f/2 \quad * \quad \sqrt{2} \quad = \quad f/2.8$$

$$f/2.8 \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

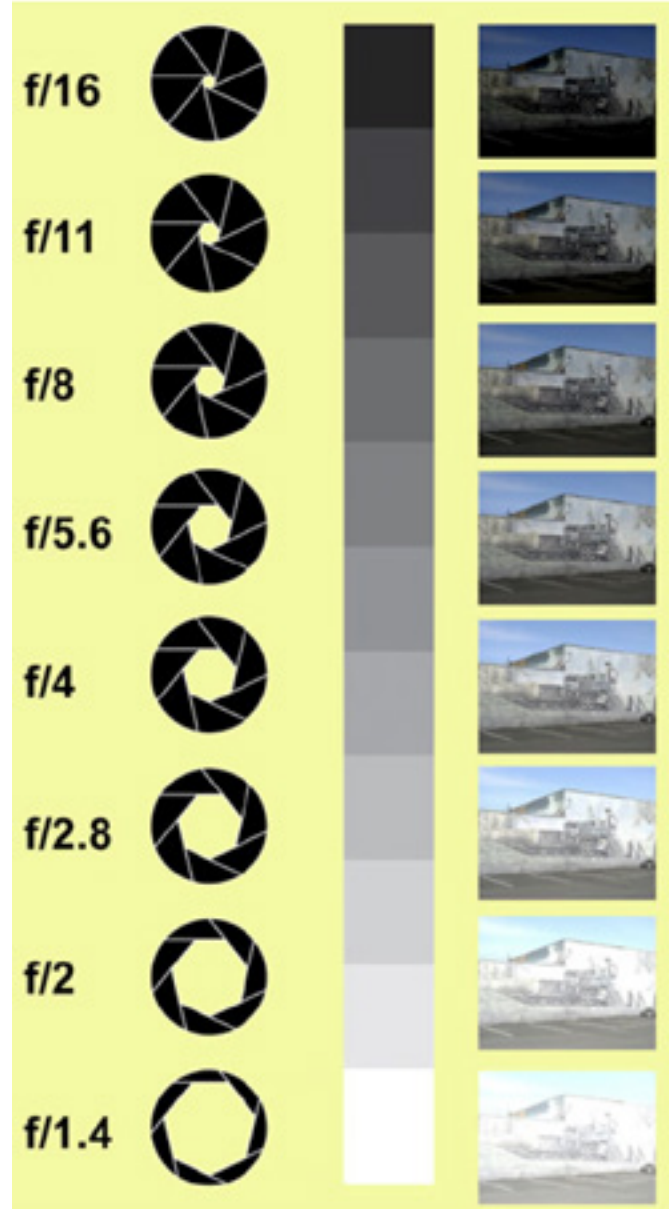
$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

$$\boxed{f/} \quad * \quad \sqrt{2} \quad = \quad \boxed{f/}$$

One \pm change in exposure value or one f /stop.

One change in a f /stop is equivalent to one change in exposure value. This change will double or half the amount of light which passes through a lens.



Factoid

Because of internal mounting of lenses there can never be a $f/1$ aperture.

Name: _____

Period: _____ Date: _____

Reciprocal Exposure Problems

Work the following problems using the Shutter Speed & *f*/stop chart for help:

Basic Whole Exposure Stops														
<i>f</i> /stops	64	44	32	22	16	11	8	5.6	4	2.8	2	1.4	Uncommon	
Shutter Speeds	4000	2000	1000	500	250	125	60	30	15	8	4	2	1s	Tripod Needed
ISO		50	100	200	400	800	1600	3200	6400	12800	25600	Professional Only		

Problem 1.

Initial exposure is ISO 1600 *f*/8 @ 1/250.

- a. How do you change exposure to allow for greater DoF using a typical lens? Explain why you chose these settings and give new exposure.

New Exposure	
ISO	
<i>f</i> /	
SS	

Reasoning:

Refined Exposure
(if needed)

ISO	
<i>f</i> /	
SS	

- b. If you wanted the greatest DoF using the chart on the bottom of page 6, what would your new exposure be? Explain why you chose these settings and give new exposure.

New Exposure	
ISO	
<i>f</i> /	
SS	

Reasoning:

Refined Exposure
(if needed)

ISO	
<i>f</i> /	
SS	

- c. How would you change the initial exposure to allow for selective focus? Explain why you chose these settings and give new exposure.

New Exposure	
ISO	
<i>f</i> /	
SS	

Reasoning:

Refined Exposure
(if needed)

ISO	
<i>f</i> /	
SS	

Reciprocal Exposure Problems

Work the following problems using the Shutter Speed & f/stop chart for help:

Basic Whole Exposure Stops														
f/stops	64	44	32	22	16	11	8	5.6	4	2.8	2	1.4	Uncommon	
Shutter Speeds	4000	2000	1000	500	250	125	60	30	15	8	4	2	1s	Tripod Needed
ISO		50	100	200	400	800	1600	3200	6400	12800	25600	Professional Only		

Problem 2.

Initial exposure is ISO 800 *f*/5.6 @ 1/250.

- a. How do you change exposure to allow for greater DoF? Explain why you chose these settings and give new exposure.

New Exposure Reasoning:

ISO	
<i>f</i> /	
SS	

Refined Exposure (if needed)

ISO	
<i>f</i> /	
SS	

- b. If you wanted the greatest DoF using the chart what would your new exposure be? Explain why you chose these settings and give new exposure.

New Exposure Reasoning:

ISO	
<i>f</i> /	
SS	

Refined Exposure (if needed)

ISO	
<i>f</i> /	
SS	

- c. How would you change the initial exposure to allow for selective focus? Explain why you chose these settings and give new exposure.

New Exposure Reasoning:

ISO	
<i>f</i> /	
SS	

Refined Exposure (if needed)

ISO	
<i>f</i> /	
SS	

Name: _____

Period: _____ Date: _____

Depth-of-Field or DoF

The Basics

DoF is the variable distance between two points that is or is not in focus. It is a measure of how much of a picture is in focus.

A lens only focuses at a single point, but there will be an area or zone of acceptable sharpness stretching in front and behind this point still appearing sharp.

This zone is known as the depth of field. It's not a fixed distance, it changes in size and can be described as either **shallow** (where only a narrow zone appears sharp) or **deep** (where more of the picture appears sharp).

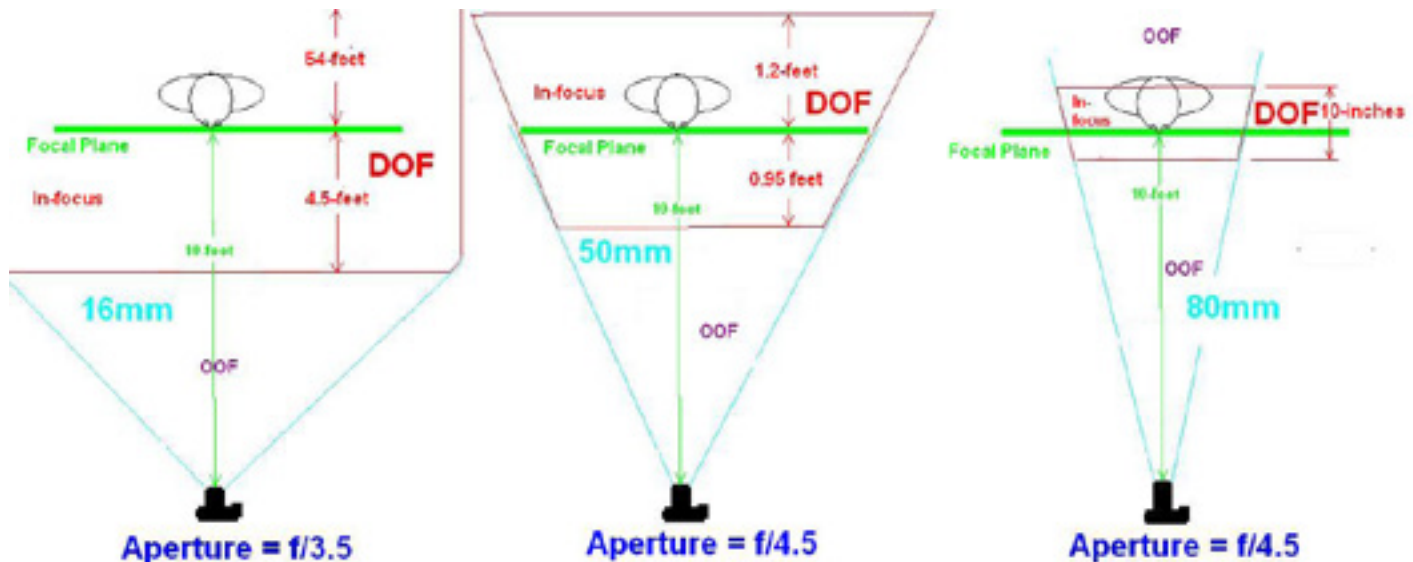
It is dependent on three things:

1. the focal length of the lens
2. the distance from the lens
3. the *f*/stop (aperture)

Images are often discussed in terms of **shallow** (little in focus) or **deep** (lots in focus) DoF.

Generally:

- *f*/stops with smaller openings like *f*/ 11+ will produce an image with a **deeper** or greater DoF.
- *f*/stops with larger openings like *f*/ 2.8 or wider (larger hole) will produce an image with a **shallow** or lesser DoF.



Distance, Focal Length & Depth-of-field

- Depth-of-field increases with distance. The farther the camera is from a subject, the deeper DoF.

Example

- Subject is photographed from five and then from 20 feet away
- Zone of sharpness (DoF) in the foreground and background is deeper (greater) at 20 feet.
- Landscapes generally have deeper (greater) DoF.
- Macro (close-up) photographs tend to have very little DoF because the subject is close to the lens.
- If the lens focal length and shooting distance stay the same, the depth of field is deeper at *f*/16 than *f*/1.4.
- Shorter lens focal length = deeper DoF (all else the same).

Example

- 28mm lens vs. 50mm lens with same aperture and shooting distance.
- 28 mm lens has deeper DoF.

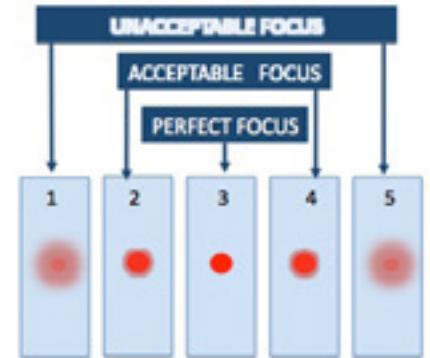
Depth-of-Field or DoF

Circles of Confusion

The **circle of confusion** is defined as the largest blur spot that is indistinguishable from the point source being rendered.

The term **CoC** is used to define how much a point needs to be blurred in order to be perceived as unsharp. When the CoC becomes perceptible to one's eyes, this region is said to be outside the depth-of-field and thus no longer **acceptably sharp**.

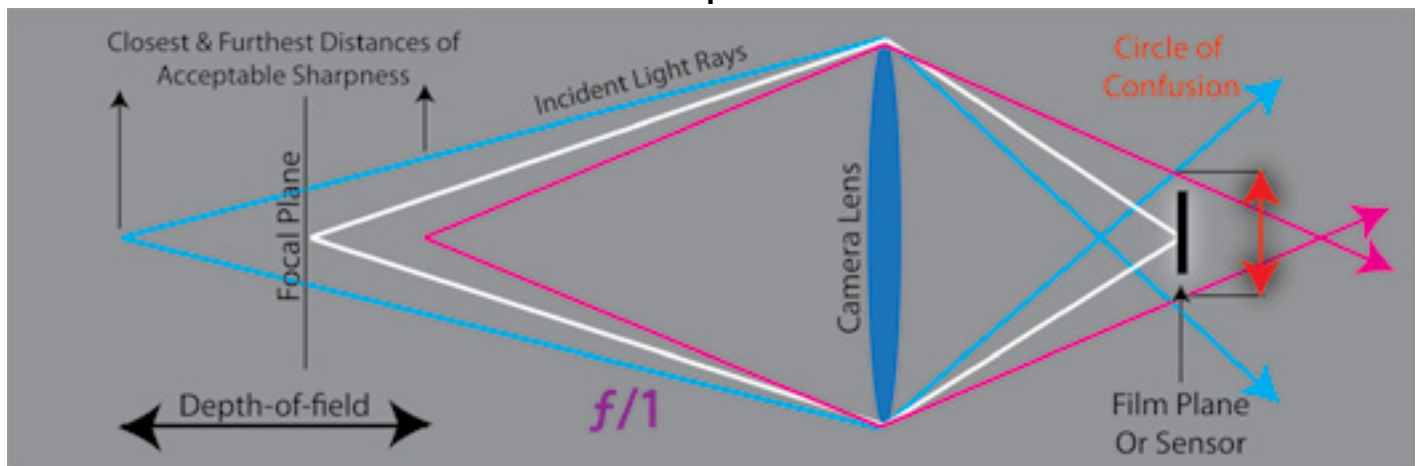
Another way to think about this is inside the DoF the CoC is seen as a tiny, sharp point. As a subject nears the edge of the DoF the CoC will grow gradually. As the subject moves beyond the edge of DoF zone the CoC point is large enough to be seen. Now the subject is out of focus, unsharp, beyond the point of being acceptably sharp. It will become more blurred as the subject continues toward the lens. Outside DoF zone a larger CoC overlapping with other points nearby creating a blurred area of the image.



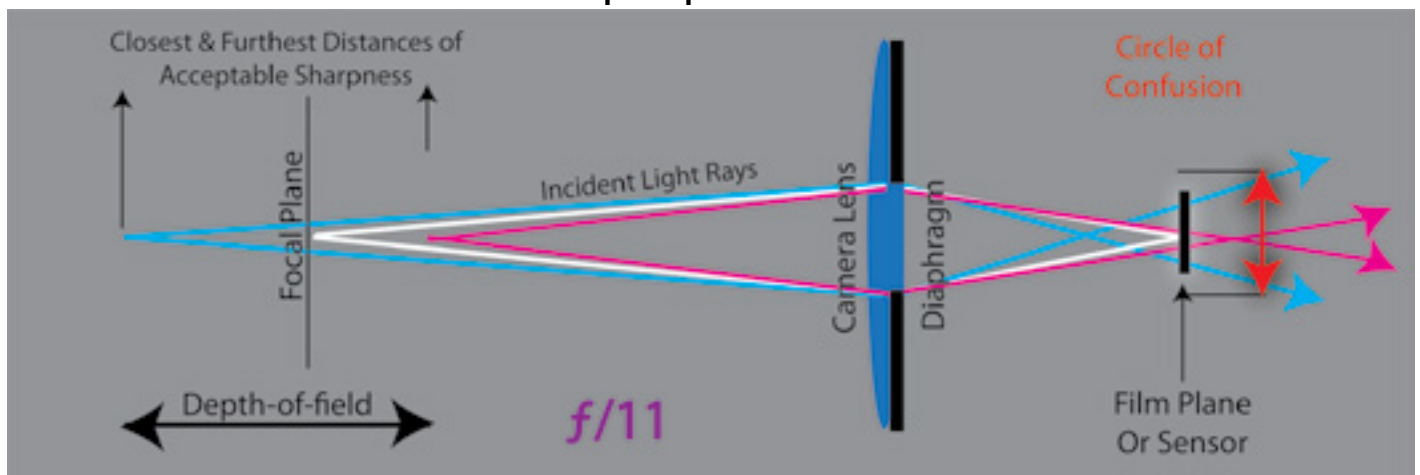
Visit DBP Consulting's web page at <http://www.dbp-consulting.com/Photography/CircleOfConfusion.html> and try out the COC Tool.

The CoC below has been exaggerated for clarity; in reality this would be only a tiny fraction of the camera sensor's area.

Shallow Depth-of-Field



Deep Depth-of-Field



Name: _____

Period: _____ Date: _____

Depth-of-Field or DoF

Selective Focus

Selective focus uses shallow DoF to place the center of attention on the subject by throwing all other objects out of focus. Only the subject is in clear focus everything else is blurry.

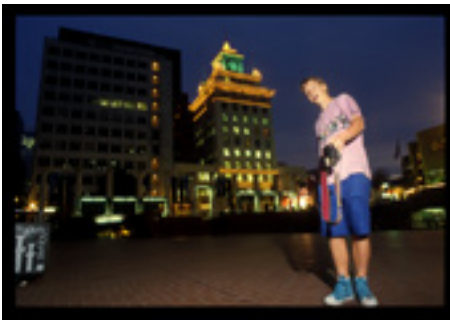
This is done by:

- Using low f /stop
- Large aperture
- Close focus

Shallow • Selective Focus



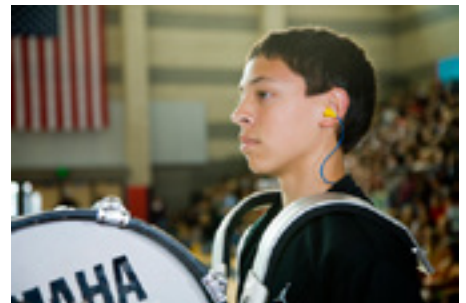
Deep



Shallow • Close up



Shallow



Sunny 16 Rule

1/ISO @ f/16 on a sunny day






between 9 a.m. and 3 p.m. (3 hrs. after sunrise / 3 hrs. before sunset)

So ISO 400 means 1/500 (it's closest, there is not a 1/400 shutter speed) @f/16

Aperture (full stops)		SUNNY	Shutter (sec) (full stops)
1/√(1)	f/1		4
1/√(2)	f/1.4		2
1/√(4)	f/2		1
1/√(8)	f/2.8		1/2
1/√(16)	f/4		1/4
1/√(32)	f/5.6		1/8
1/√(64)	f/8		1/15
1/√(128)	f/11		1/30
1/√(256)	f/16		
1/√(512)	f/22		
			1/125
			1/250
			1/500
			1/1000
			1/2000
			1/4000
			1/8000

± 1 stop = ∓ 1 stop

Slightly underexpose slides
Slightly overexpose negatives

Use the Sunny 16 rule to decide the proper exposure under the following conditions:				
Start with a shutter speed of 1/(Iso Speed) rounded to the closest, higher, full stop				
Snow, Bright Sand, Glare	Sunny Day	Hazy, Sunny Day	Bright, but Cloudy	Overcast or in Shade
				
f/22	f/16	f/11	f/8	f/5.6
Glare and Sharp Shadows	Strong Shadows	Shadows with soft edges	Barely Visible Shadows	No Visible Shadows

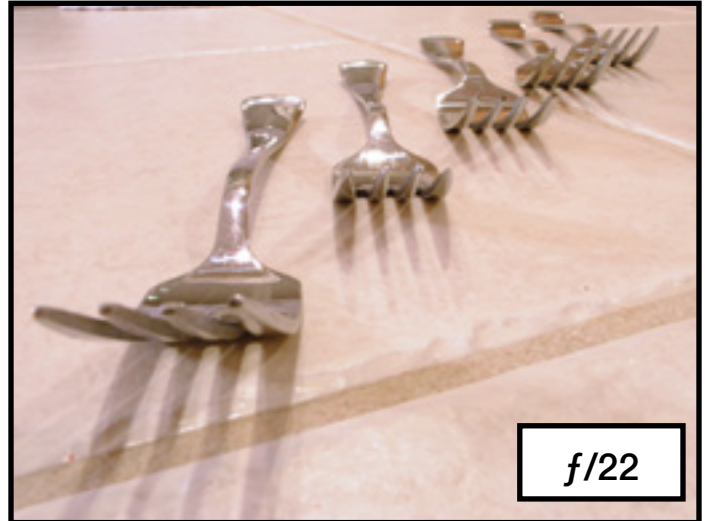
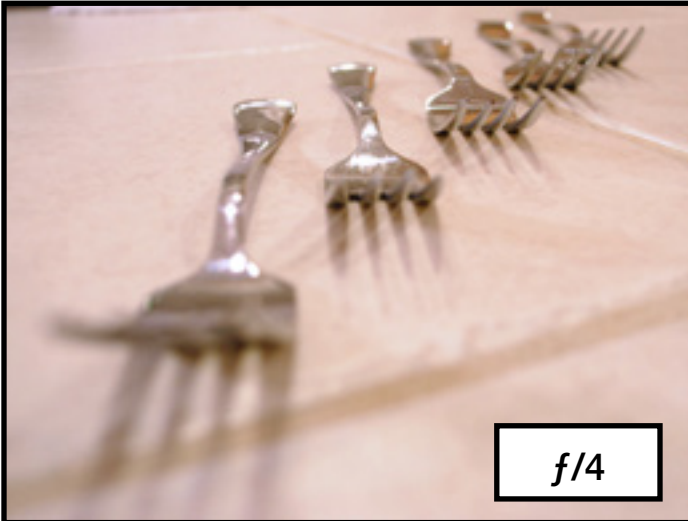
Name: _____

Period: _____ Date: _____

Depth-of-Field Assignment

Shallow Depth-of-field
f/2, f/2.8, f/4

Deep Depth-of-field
f/11, f/16, f/22



Depth-of-Field Assignment

How to set up your composition & directions

f/11-22

Focus Lens Here

Area in Focus

Area in Focus

f/2-4

f/11-22

Directions

You are to take **eight sets of two photos** (16 photos total) demonstrating shallow and deep depth-of-field.

Each set consists of:

- **Identical photos** with the **same exact** content and focus.
- **Five similar items** in a row.
- The only change should be the *f*/stop with the exposure adjusted (± 0) so the **exposure is reciprocal** between the two.
- One photo should be with an *f*/stop less than *f*/4 (or as low as you can get i.e. *f*/5.6).
- The other photo should be with an *f*/stop greater than *f*/11 (*f*/16+ better).

Remember to adjust shutter speed and/or ISO when changing *f*/stop. All photos should have reciprocal exposures.

What to turn in

1. This worksheet fully filled out
2. Contact sheet fully labeled with exposures
3. One set of favorite photos printed out w/exposures
4. Aperture & *f*/stop rubric

Name: _____

Period: _____ Date: _____

Set #1

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #2

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #3

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #4

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Name: _____

Period: _____ Date: _____

Set #5

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #6

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #7

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Set #8

Describe location in detail including weather and light conditions:

Exp. #	ISO	f/stop	Shutter Speed	Shallow or Deep	Comments & Notes, Detail when Taking Photo

Name: _____

Period: _____ Date: _____

Reflection Questions

- When is the use of bracketing suggested?
- If initial exposure reading is **ISO 400 f/4 @ 1/125** when **bracketing** by **+2 stops**, what would the new exposure be (there are **at least three** answers)? Remember to list all exposure components for each answer..

A. _____

B. _____

C. _____

3. Reciprocal Exposure Problems

Initial exposure is ISO 400 f/4 @ 1/250.

- How do you change exposure to allow for greater DoF? Explain why you chose these settings and give new exposure.

New Exposure	Reasoning:
ISO	
f/	
SS	

Refined Exposure (if needed)	
ISO	
f/	
SS	

- If you wanted the greatest DoF using the chart what would your new exposure be? Explain why you chose these settings and give new exposure.

New Exposure	Reasoning:
ISO	
f/	
SS	

Refined Exposure (if needed)	
ISO	
f/	
SS	

3. **Reciprocal Exposure Problems** (cont.) Initial exposure is ISO 400 $f/4$ @ $1/250$.

c. How would you change the initial exposure to allow for selective focus? Explain why you chose these settings and give new exposure.

New Exposure Reasoning:

ISO	
$f/$	
SS	

Refined Exposure (if needed)

ISO	
$f/$	
SS	

4. How do you know if you have a “fast” lens?

5. How did changing the aperture effect exposure?

6. What happens to DoF when your subject is close to the camera?

7. What type of composition typically lends itself to this assignment?

8. What happens to the **amount of light** when you...

(don't use the term “stop” in your answer give a relative amount of light)

...increase your $f/$ stop by one?	...decrease your $f/$ stop by one?

Name: _____

Period: _____ Date: _____

Reflection Questions (cont.)

9. If your ISO setting is 400 and the light meter reads 1/60 @ *f*/8 then:
- Would you change your aperture to show deep DoF?
 - Would you change your aperture to show shallow DoF?
 - Would you change your aperture to show selective focus?
 - Would you change your aperture to show foreground and background in focus?

	Y	N	How change? New exposure	My reasoning behind the change:												
a	Yes, I'd change the exposure.	No, I'd leave the exposure the same.	How I'd change: Version 1 <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table> Revision (as needed) <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	ISO	<i>f</i> /	SS				ISO	<i>f</i> /	SS				
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b	Yes, I'd change the exposure.	No, I'd leave the exposure the same.	How I'd change: Version 1 <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table> Revision (as needed) <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	ISO	<i>f</i> /	SS				ISO	<i>f</i> /	SS				
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ISO	<i>f</i> /	SS														
ISO	<i>f</i> /	SS														
d	Yes, I'd change the exposure.	No, I'd leave the exposure the same.	How I'd change: Version 1 <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table> Revision (as needed) <table border="1"> <tr> <td>ISO</td> <td><i>f</i>/</td> <td>SS</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	ISO	<i>f</i> /	SS				ISO	<i>f</i> /	SS				
ISO	<i>f</i> /	SS														
ISO	<i>f</i> /	SS														

Reflection Questions (cont.)

10. How is DoF effected when using a longer focal length lens?

11. Using the Sunny 16 Rule, if your ISO is 800 what would your exposure be? What kinds of adjustments might you have to do & why?

New Exposure		Reasoning:
ISO		
<i>f/</i>		
SS		

Refined Exposure (if needed)	
ISO	
<i>f/</i>	
SS	

12. Which camera settings produced the best final images for you? Think about how depth-of-field was demonstrated in your photos when explaining why you think these settings worked the best. Remember there are two types of DoF.

13. In your words, what was the hardest and easiest part of this assignment for you?

14. What did you learn that you did not expect?

Name: _____

Period: _____ Date: _____

15. Why did you pick your favorite photo and how does it demonstrate what you have learned about apertures and *f*/stops?

16. Describe the composition of your favorite photo set.

17. Can you add any information which will assist me in determining your grade?

18. How would you change this assignment to improve it for future students? Note: the math needs to stay.