Camera Sensor Sizes

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In this lesson, we're going to look at how the sensor size in your camera can affect various aspects of your photography. This will include how it affects the focal length of the lens you're shooting with, how it affects the aperture setting as well as resolution and noise. All of these things will change as we change the sensor size.

The sensor sizes we currently use are based on film sizes of the past. (Medium format is anything larger than 35mm. Full frame is equivalent to 35mm.)

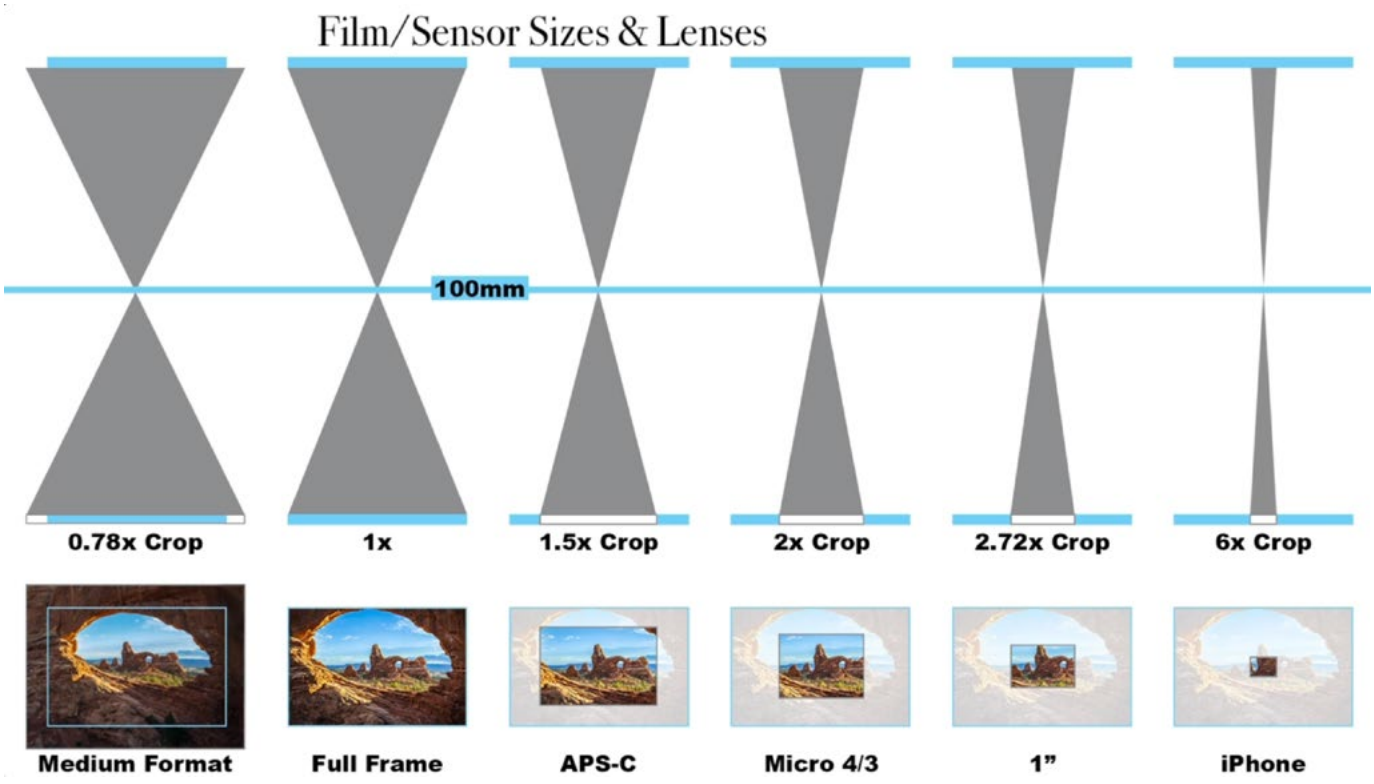
The sensor sizes we currently use are based on film sizes of the past. Various film sizes are shown above and the current sensor sizes are shown below.

Film/Sensor Sizes & Lenses (9:56)

A crop factor determines how much smaller a sensor is compared to a full frame sensor. In the diagram below, the bottom blue bar represents the width of the camera sensor and the top blue bar represents the width of the scene you're photographing.

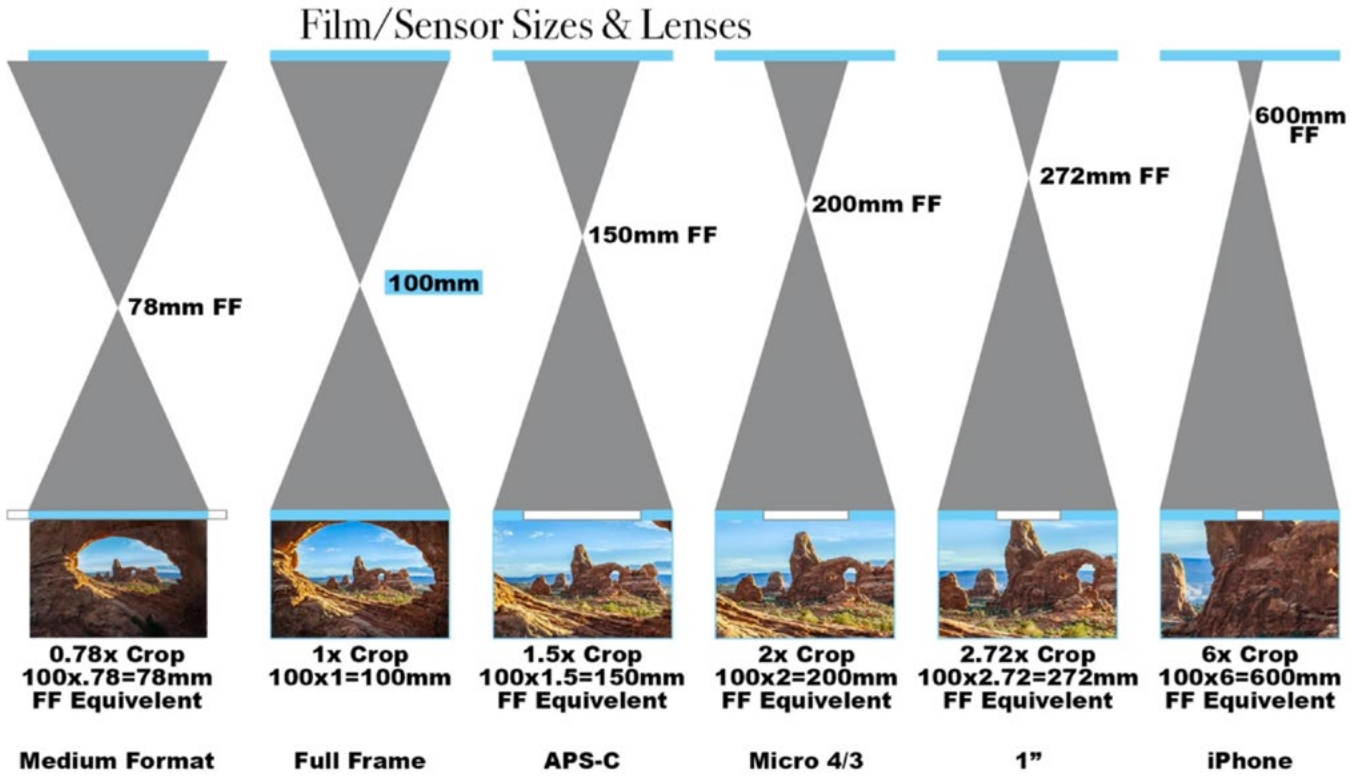
The light that's coming from the scene you're photographing will go into the lens and get concentrated down to a single point before reversing and coming back out. If you measure the distance between the camera sensor and the place where the light is concentrated to a single point, that will be the focal length of the lens.

The diagram shows how much of the scene will be captured using a 100mm lens with different sensor sizes. You can see that the same lens will end up producing a different result on cameras with different sensor sizes. Smaller sensors will crop the image and that's why they're referred to as cropped frame sensors.



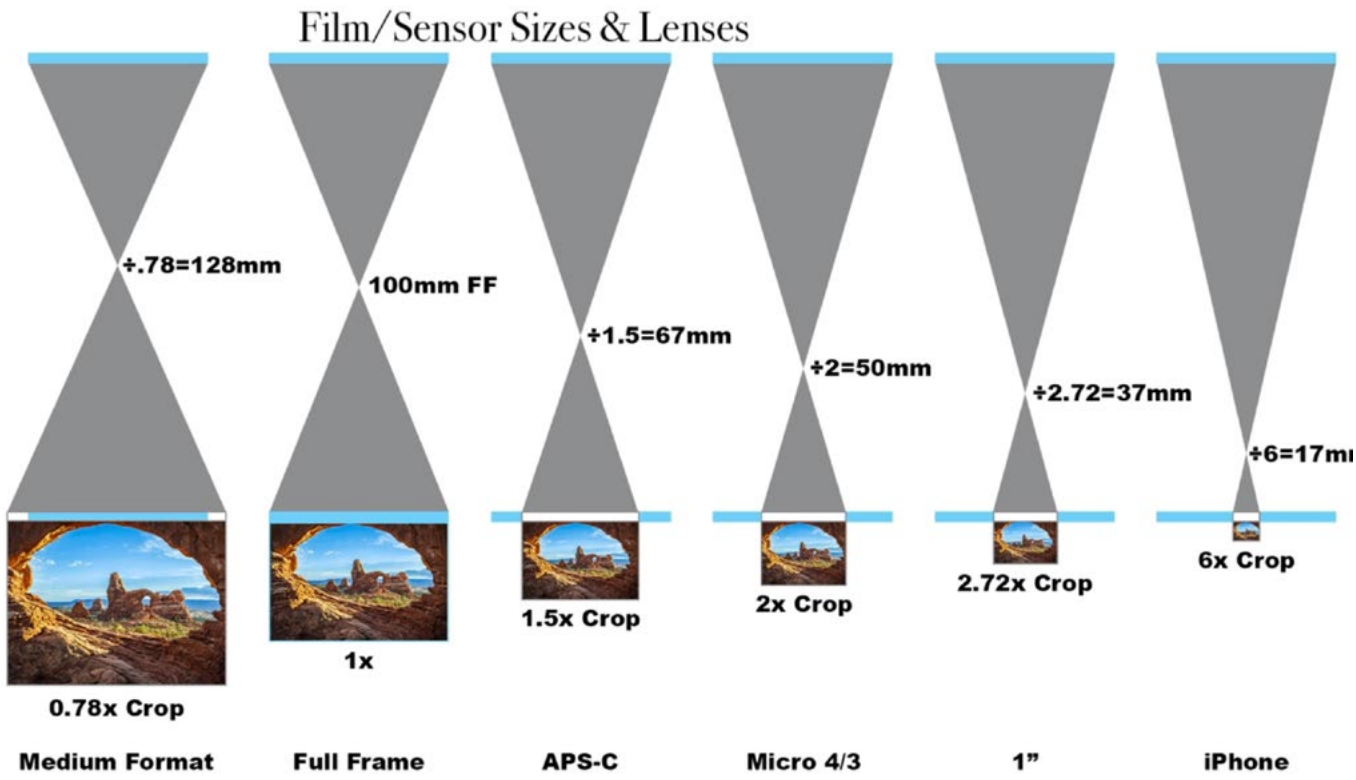
Multiply the focal length by the crop factor to determine the full frame lens needed to produce the same field of view (15:54)

If you are not shooting with a full frame/35mm camera, you can find out how to get the same results as the full frame lens by taking the crop factor of the sensor you're using and multiplying it by the focal length used by the full frame lens. For example, let's say that a full frame/35mm camera uses a 100mm lens to capture a particular scene. If you are using a camera with a 1.5x crop factor, you'd multiply that crop factor (1.5) by the focal length of the lens used by the full frame camera (100), and you would get 150. This means you'd need to use a 150mm focal length to capture the same scene.



Divide the full frame focal length of a lens by the crop factor to determine the lens needed to produce the same field of view on a different sized sensor (18:56)

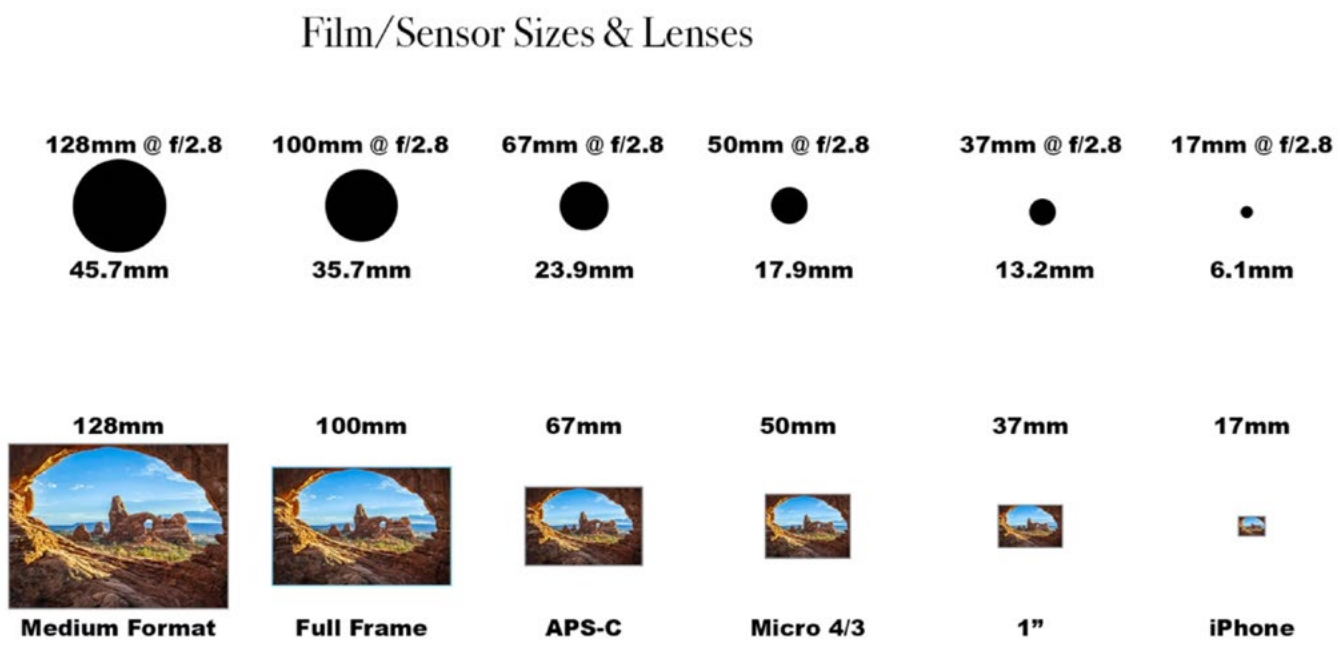
If you'd like to get the same look of a particular lens on a full frame camera, take the focal length of that lens you're trying to emulate and divide it by the crop factor of the camera you're currently shooting with. The result will be the focal length you'd need to use to get that same look.



The focal length divided by the f-stop determines the actual aperture size (21:32)

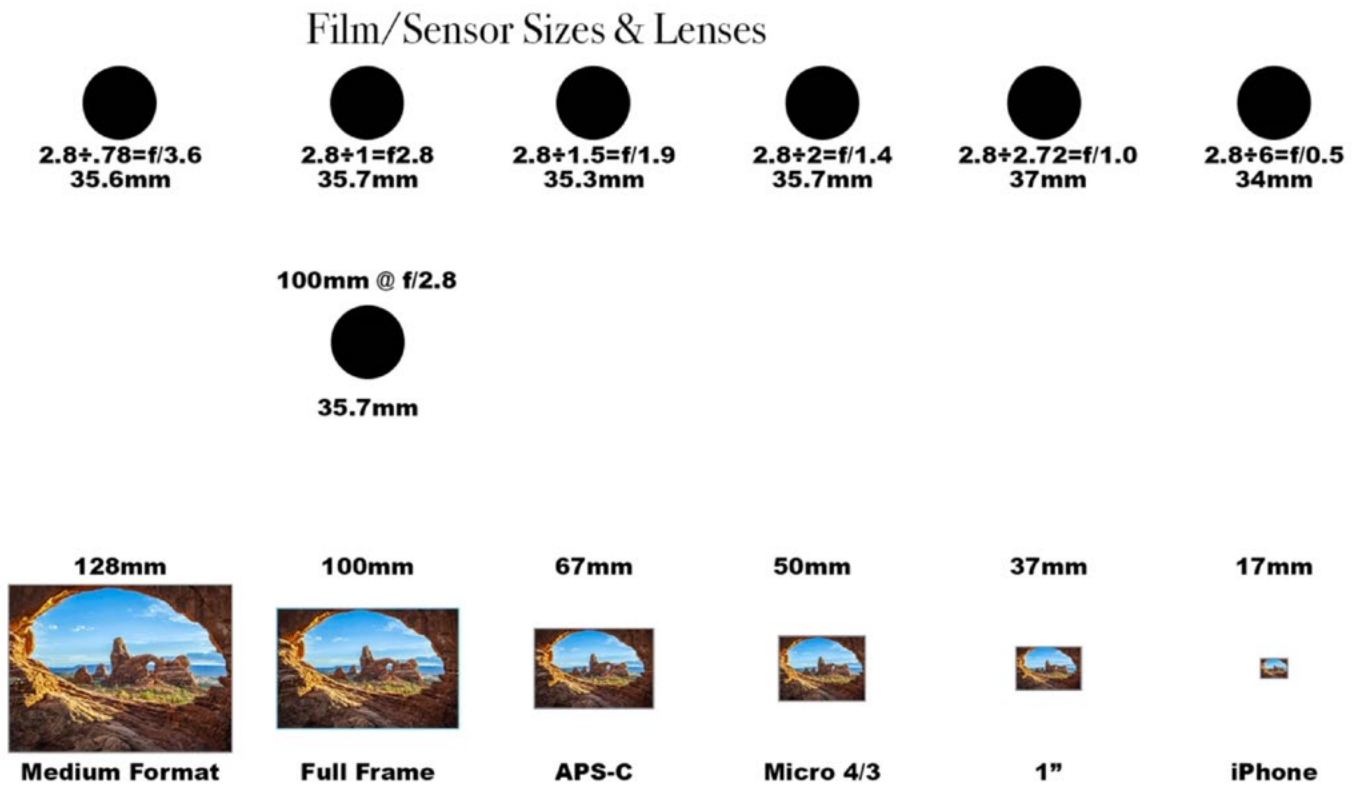
The aperture is the opening in the lens that allows light to come through and the aperture setting on your camera will determine the depth of field. This setting is represented by an “f” followed by “/“ and then a number (f/2.8 for example). This is essentially a fraction. The “f” stands for the focal length of the lens and it is divided by (/) the setting number to determine how big of an opening the lens will have to allow light through. For example, when shooting at 100mm using an aperture setting of f/2.8, the actual opening will be 35.7mm (100 divided by 2.8).

Because a different focal length is needed to capture the same scene for all the different sensor sizes, different math will be applied to each of the different sensor sizes. You can see in the diagram below that cameras with different sensor sizes will get different results when shooting with the same f-stop. If you are shooting with a micro 4/3 camera and you’d like to get the same depth of field as a full-frame camera, you will need to use different settings.



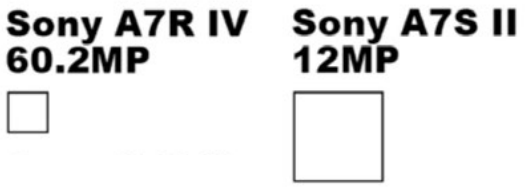
Divide the full frame f-stop by the crop factor to determine the equivalent f-stop (23:54)

If would like to get the same depth of field as a full-frame camera, you will need to take the aperture setting used by the full frame camera and divide it by the crop factor of the camera you're using.



Resolution (26:10)

The megapixel number of a camera refers to how many pixels the camera captures for each image. If you think of the pixels as making up a grid of squares across the image, the megapixel number is the number of pixels tall multiplied by the number of pixels wide. The more pixels in the image, the smaller each pixel will be.



The pixels will be much smaller on a 60MP camera than on a 12MP camera.

This megapixel number can affect the amount of noise in an image. The larger the sensor area that is being devoted to a single pixel, the less noise there will be in the image. Therefore, cameras that capture more megapixels will generally produce less noise.

The amount of noise is therefore also affected by the size of the sensor. With a smaller sensor, the pixels will be smaller and this will produce less noise.

Resolution Requirements Chart (32:20)

There is a spread sheet included with this lesson that will help you to understand sensor size and resolution. In this chart, the white fields are those in which you can enter information. The gray fields are automatically calculated for you, so you won't be able to click on those to type in a number.

Various cameras are listed on the left side of the chart and directly to the right of them are the width and height of the camera sensors, measured in millimeters. In the next field, it compares those sizes to a full frame, 35mm camera and then it automatically calculates the crop factor for each of the cameras.

There are also fields that include the width and height (in pixels) of the files that are produced by each camera. These numbers are used to calculate the number of megapixels for each camera (This is a gray field).

Sensor Size & Resolution

Camera	Pixel Size	Full Frame @ Pixel Size	Format	B&H Price	Price Per Megapixel	Largest Casual Viewer Print	Largest Critical Viewer Print	FF f/1.4 DOF Equivalent
Olympus OM-D E-M1X	3.36µm	76.7MP	Micro 4/3	$2599.00	$128.95	36x27"	21x16"	f/0.70
Hasselblad X1D II 50C	5.29µm	30.8MP	Medium Format	$5750.00	$112.12	58x43"	34x25"	f/1.77
Hasselblad H6D-100c	4.60µm	40.8MP	Medium Format	$32995.00	$326.94	81x61"	47x35"	f/2.16
Canon Ra	5.36µm	30.1MP	Full Frame	$2499.00	$83.01	47x31"	27x18"	f/1.40
Sony A7R IV	3.95µm	55.5MP	Full Frame	$3498.00	$58.09	66x44"	39x26"	f/1.44
Sony A7S II	8.44µm	12.1MP	Full Frame	$2298.00	$191.38	30x20"	17x12"	f/1.39
Nikon Z7	4.35µm	45.7MP	Full Frame	$2796.00	$61.53	58x38"	34x22"	f/1.40
FujiFilm GFX	3.76µm	61.1MP	Medium Format	$9999.00	$98.26	81x61"	47x36"	f/1.77
FujiFilm X-T4	3.77µm	60.9MP		$1699.00	$65.45	44x29"	25x17"	f/0.91
Panasonic S1R	4.30µm	46.7MP	Full Frame	$3697.00	$98.53	58x31"	34x18"	f/1.40

All of this information is used to calculate the data on the right side of the chart. The Pixel Size refers to how much space each pixel takes up on the camera's sensor. The smaller the number, the less space it takes up. Higher numbers are usually an indicator of less noise and lower numbers are an indicator of more noise.

There is a field that tells you the largest print size you could create that would still look acceptable from a casual viewing distance. This is based on how many megapixels the camera is. Another field tells you the largest print size you could create that would still look acceptable from a critical viewing distance. This is when you get up close to examine the fine details. Both of these fields are calculated based on the information found in the Viewing Distance Standards box that is located beneath the main chart. You can enter in how many inches you would consider to be a casual and critical viewing distance. When you change these numbers, the numbers in the main chart will change to reflect your preferences.

Largest Casual Viewer Print	Largest Critical Viewer Print
36x27"	21x16"
58x43"	34x25"
81x61"	47x35"
47x31"	27x18"
66x44"	39x26"
30x20"	17x12"
58x38"	34x22"
81x61"	47x36"
44x29"	25x17"

Viewing Distance Standards

Casual Viewer Distance in inches	Critical Viewer Distance in inches
24	14

The three columns on the far right side of the chart will give you the f-stops each camera would need to use in order to get the equivalent depth of field as a fast zoom lens on a full frame camera.

FF f/1.4 DOF Equivalent	FF f/2.8 DOF Equivalent	FF f/4 DOF Equivalent
f/0.70	f/1.41	f/2.01
f/1.77	f/3.54	f/5.06
f/2.16	f/4.32	f/6.17
f/1.40	f/2.80	f/4.00
f/1.44	f/2.87	f/4.11
f/1.39	f/2.79	f/3.98
f/1.40	f/2.79	f/3.99
f/1.77	f/3.54	f/5.06
f/0.91	f/1.83	f/2.61

Lens Comparison There is a smaller chart in the spreadsheet called "Lens Comparison." This allows you to enter in the focal length of various lenses, the maximum aperture number and your camera's crop factor. It will use this information to tell you what focal length and aperture you would need to use to get the equivalent result to a full frame camera.

Lens Comparison

Focal Length mm	Aperture f/	Camera Crop Factor	FF Equivalent Focal Length	FF Equivalent Aperture
600	4	1.99	302	8.0
300	4	1	300	4.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0

Sensor/Lens/f-stop Comparison In the "Sensor/Lens/f-stop for Comparison" box, you can enter in a specific sensor crop factor, focal length and f-stop. The box below that, titled "Comparison Results," will tell you the equivalents for various sensor sizes.

Sensor/Lens/F-stop for Comparison

Sensor Crop Factor	Focal Length	f-stop
1	300	4

Comparison Results

Format	Focal Length	f-stop
Medium Format	380	5.1
Full Frame	300	4.0
APS-C	200	2.7
Micro 4/3	150	2.0