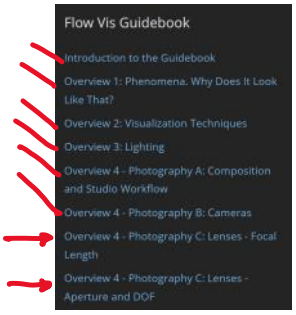
10 Photography 2:lenses - focal length - focus

Monday, September 19, 2022 12:45 PM

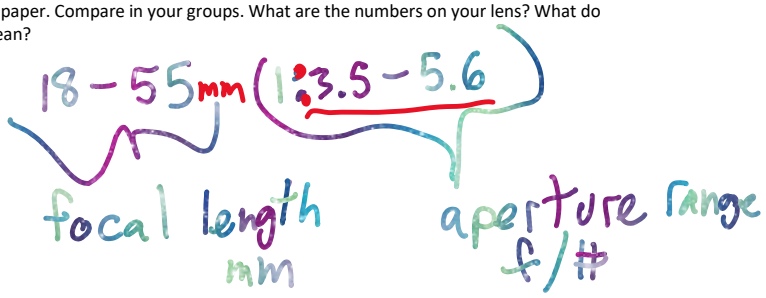
- Lenses
  - Typical lenses
  - Focal lengths

Reading Assignment:



1. LENSES

Minute paper. Compare in your groups. What are the numbers on your lens? What do they mean?



Anybody have this?

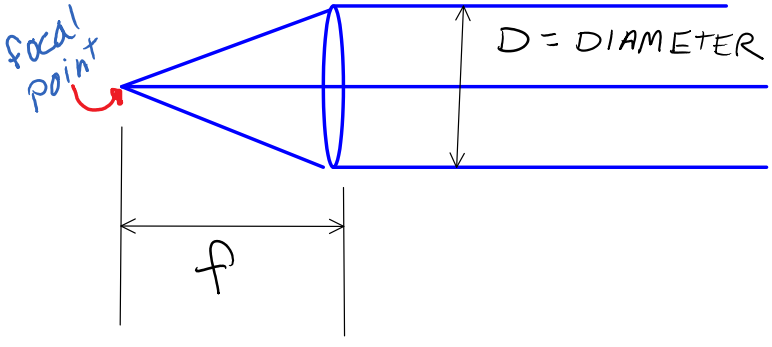
ϕ77mm

Ø Symbol for thread diameter, for attaching filters etc.
Ø (or minuscule: **ø**) is a letter used in the Danish, Norwegian, Faroese, and Southern Sámi languages.

From <https://en.wikipedia.org/wiki/%C3%98>

Lenses are defined by FOCAL LENGTH and APERTURE and optical Diameter

f = focal length = distance from center of lens system to sensor when focused at infinity



Aperture = f/D

Dimensionless number. More on aperture later.

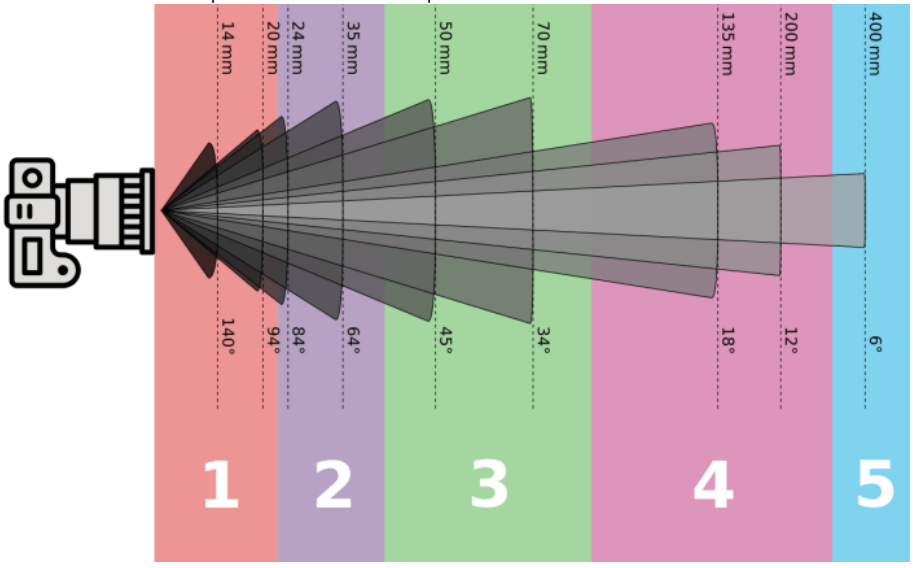
Where is f measured? Lens barrels can be 6 inches long or more! And contain a dozen different lens elements.

There is an *effective* center, and you may never know where it is, but we need to use it to understand how lenses work.

Symbol for center of
lens
Or sensor location

Variable focal length = ZOOM lens.
Now is default. Non-zoom are called 'prime' lenses.

10 years ago, 35 mm film cameras were standard, and the
standard lens was 50 mm, giving an FOV (field of view) roughly equivalent to a human.
Lenses now are sometimes spec'd as 'XXmm 35 mm equivalent'



Lenses classified by 35 mm equivalent and FOV. 1= ultra wide, 2= wide angle, 3= normal, 4= short telephoto (70-85mm) / medium telephoto (100-200mm), 5= super telephoto (300-400mm) / ultra telephoto (500-1200mm). MikeRun, CC BY-SA 4.0, via Wikimedia Commons.

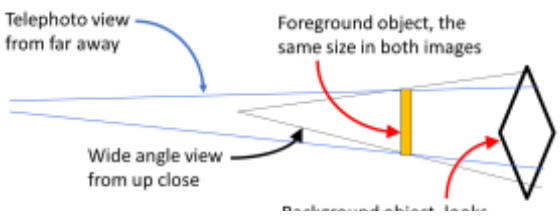
From <https://www.flowvis.org/Flow%20Vis%20Guide/overview-4-photography-3-lenses/>

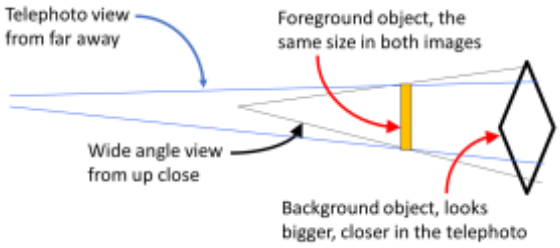
FOV = Field Of View

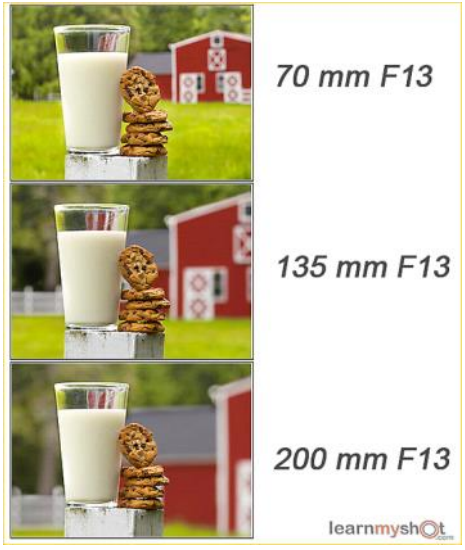
FOV is determined by focal length and sensor size. Cameras with smaller sensors will have shorter lenses than a 35mm camera for the same FOV. Online calculators will tell you equivalents.

Impact of focal length on framing:

https://youtu.be/H09LKsTsQ-s Lens Compression (7 minutes)







Hands on! Do this now!

1. Pick up your camera and zoom in on an object in front of you.
2. Note the relative size of something beyond it, in the background.
3. Then walk in close, and zoom out until the foreground object is the same size in the viewfinder as it was in the previous image, and
4. notice how the size of the background object got smaller.

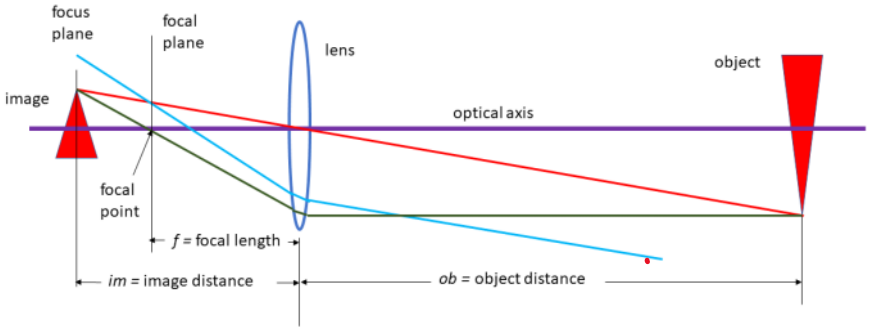
From <https://www.flowvis.org/Flow%20Vis%20Guide/overview-4-photography-3-lenses/>

https://www.youtube.com/watch?v=4yyFKNfRq_M Learn My Shot. Same images, 2.5 minutes

3) LENSES

FOCUS

'In focus' when all collected light from a point on the object shows up at a single point in the image.



Lens laws:

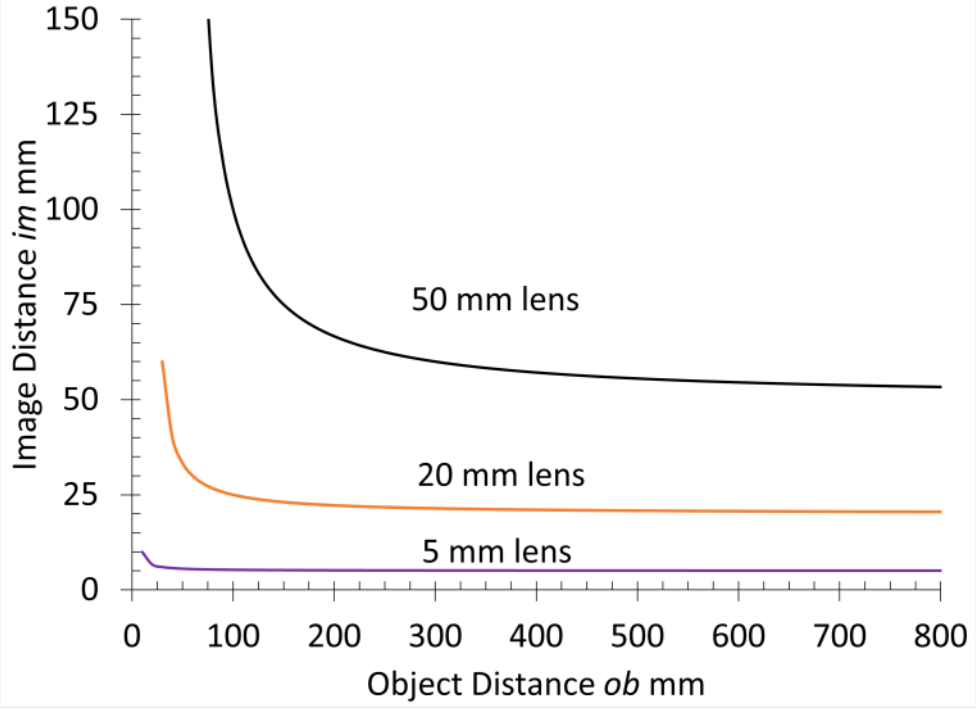
1) light through center of lens is undeflected
2) light parallel to axis goes through focal point
3) all light entering lens at a given direction ends up at the same point in the focal plane

4) Lens focus (lensmaker's) equation:

$$\frac{1}{f} = \frac{1}{Ob} + \frac{1}{Im}$$

When object is at infinity, image forms at one focal length from the lens. For a set focal length, as an object moves closer, lens must move away from sensor plane to keep focus plane at sensor. Mechanical limit defines closest possible object distance for focus.

TRY THIS NOW
Change the focus distance on your camera. How does the physical length of the lens change?

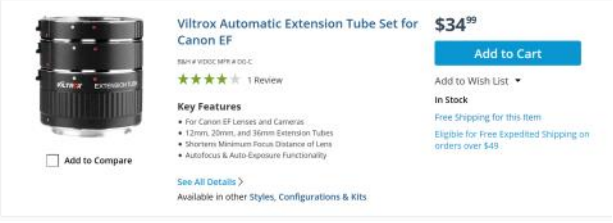


This is why small cameras with small sensors and short focal lengths have better macro capability than larger cameras.
Hardly have to move the lens at all.

$$\frac{1}{f} = \frac{1}{im} + \frac{1}{ob}$$
$$\frac{1}{im} = \frac{1}{f} - \frac{1}{ob}$$
$$1 = \left(\frac{1}{f} - \frac{1}{ob}\right) im$$
$$\frac{1}{\frac{1}{f} - \frac{1}{ob}} = im$$

Macro Photography: Techniques for close focus

Extension tubes (for DSLR) allow lens to move further out and focus closer.



https://www.bhphotovideo.com/c/search?Ntt=Canon%20Extension%20Tube&N=0&InitialSearch=yes&ap=Y&gclid=CjwKCAjwn9v7BRBgEiwAbq1Ey4UGoJ7JL17VJ8nuohuDReoMd_oQrovcpFcIEQC8WZVny-elgAgaiRoC11AQAvD_BwE

Check that electronic capability for autofocus and auto exposure are there; wiring goes through tubes

Simple lenses are reversible. Lens systems are not.
"Reverse macro" adapters let you turn the lens around, or put a reversed lens at the

end of your normal lens. $15.
Caution, interior lens element is now exposed, easily scratched.

'Close up' lenses allow close focus by changing system f . Long f lens, threads on to the outer end of main lens (threads standard, but need to match diameters). Lower quality, though. Each additional lens element can lose 10% of light, introduce aberrations.
PHD cameras and cell phones often lack threads. You can just hold a close up lens out in front, or mount to cardboard tube. Check focus often.
Inexpensive, $6 for set of 4. Available for camera phones too.

Spec'd in 'diopters' = 1/f in meters. Typically +1, +2, +4 $\frac{1}{f_T} = \frac{1}{f_1} + \frac{1}{f_2}$

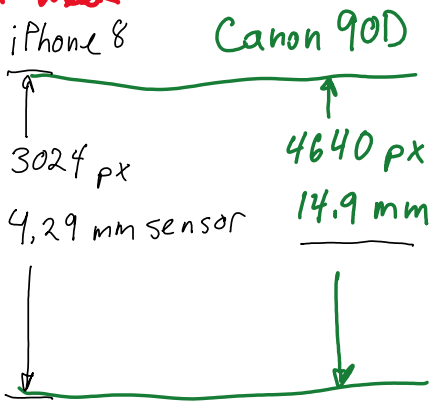
Macro Homework Exercise:

1. Can you get the most magnification by zooming out and moving close, or by zooming in and moving back?
2. At which extreme can you focus closest? What is the minimum distance? What is the FOV there?
3. Make an image of a 25¢ coin. At what lens settings do you get the greatest magnification, where the coin is as large as possible in the image and still sharply in focus?
4. Make the same image with three f/stops: max, min and low medium. (Try to keep overall exposure and ISO the same, and use tripod or keep shutter time short.) Inspect the three images closely for focus, depth of field and overall sharpness. What happened?

Enter your data in this spreadsheet:
https://docs.google.com/spreadsheets/d/1WeUigolyQ80W2QfFvzXmn9omN4Yx621oaquPcuttUVY/edit?usp=sharing

When should this be due? Thurs next week October 5

Example: iPhone 8 and Canon 90D



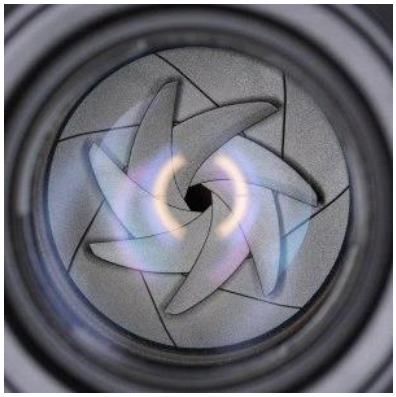
1090 px → iPhone 8

1775 px | 90D & 24-105 mm lens Best

	iPhone 8	90D
% of frame	$\frac{1090}{3024} \times 100 = 36\%$	38%
Magnification = Image size / Object size	$\frac{0.36 \times 4.29\text{ mm}}{24\text{ mm}} = 0.064$	$\frac{0.38 \times 14.9\text{ mm}}{24\text{ mm}} = 0.24$

Both cameras can magnify coin to about 1/3 of frame.
But sensors and lenses are different sizes.

Focus, Aperture and DOF



Overlapping leaflets form an iris with a variable diameter opening, here from a Canon EF-M 32mm F1.4 STM lens. D-Kuru, CC BY-SA 4.0 via Wikimedia Common

From <https://www.flowvis.org/Flow%20Vis%20Guide/overview-4-photography-c-lenses-aperture-and-dof/>

Aperture spec = F number, F#, f/, f-stop = f/D = focal length/ optical hole diameter

Inverse of hole diameter
The larger the hole, the smaller the f/
Range is usually f/1.4 to f/22

- What is yours? How does it change with zoom?
- On consumer cameras, f/ will change with zoom.
- Not so for professional lenses.