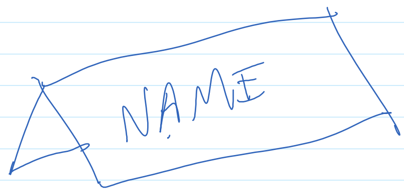
Today:

- Lenses
  - Lens laws
  - Typical lenses
  - Focal lengths
  - Aperture, depth of field

JH Bring to class:
Closeup lenses
extension tubes
Iris
View camera

Please make a table tent with your name on it



PHOTOGRAPHY FUNDAMENTALS

1) Framing
2) Camera
3) Lenses
4) Exposure Control
5) Resolution

3) LENSES

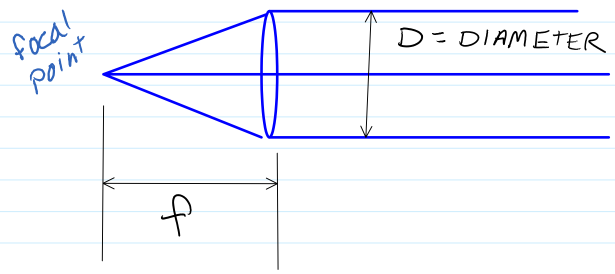
Minute paper. What are the numbers on your lens? What do they mean?

$\underbrace{\text{4.5 – 90.0 mm}}_{\text{focal length}}$ $\underbrace{\text{1:3.5 – 6.8}}_{\text{aperture}}$ $\underbrace{\text{20x}}_{\text{optical zoom}}$ $\underbrace{\text{IS}}_{\text{Image Stabilization}}$

f

Lenses are defined by FOCAL LENGTH and APERTURE and Diameter

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



Symbol for center of lens
Or sensor location

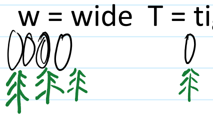
Ø Symbol for thread diameter

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. f> 50 mm = telephoto long
f < 50 mm = wide angle short

Aperture defined as f/D = f/ = f number = f#
INVERSELY related to diameter.
Nondimensional. More about aperture later.

PHDs have small sensors, so focal lengths and diameters are smaller:
Common values for PHD cameras:
f = 5 - 60 mm,   f/ = 4 - 8
28-336 mm equivalent to 35 mm, i.e. same FOV
w = wide T = tight, or telephoto



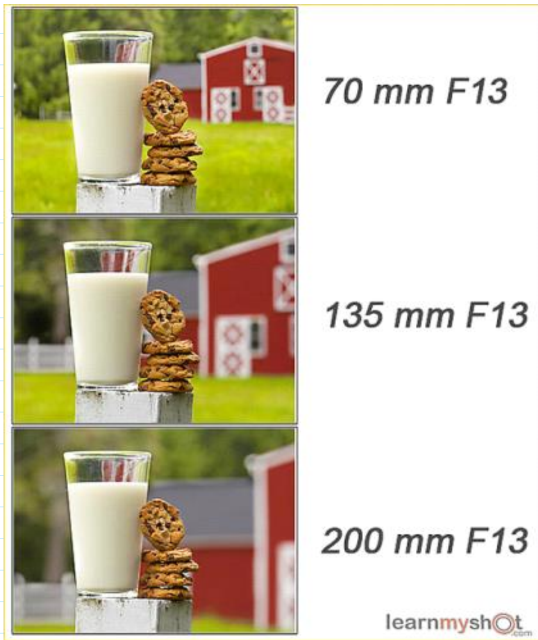
18-55
18-200
18-135

For DSLR, bigger sensors, up to 'full frame' 35 mm
f = 18- 60 mm, f/ 1.8 - 22

NUMBERS
LENS FOCAL LENGTHS
2.8 – 5.2 / 6.3 – 18.9 mm
f NUMBER RANGE
Wide angle
ZOOM
Telephoto

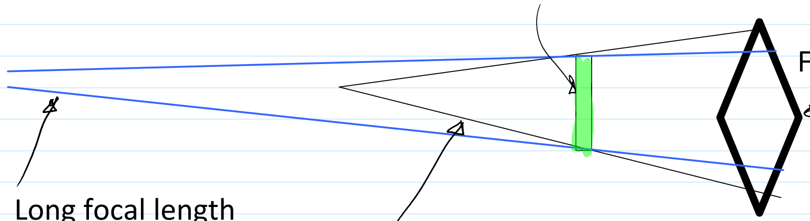
Impact of focal length on framing:

As f increases (longer lens),   field of view narrows
'Telephoto compression' happens too



http://www.learnmyshot.com/Telephoto-Lens-Perspective-Compression-and-the-Angle-of-View   Dead website 9/2/15

Near object, same size
in both images



Far object

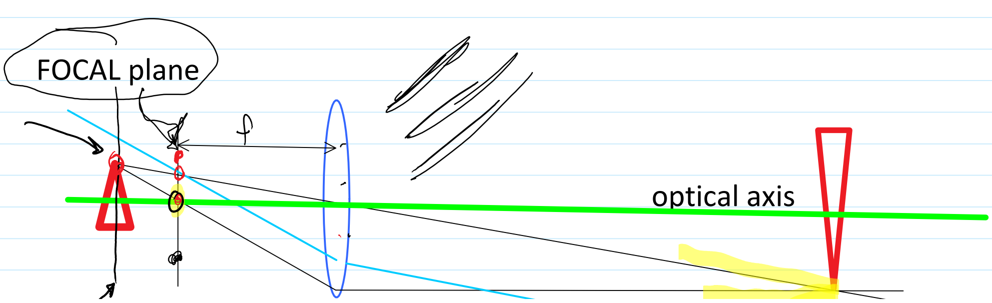
Long focal length
telephoto, narrow
FOV

Short focal length, wide angle

TRY THIS NOW

FOCUS

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



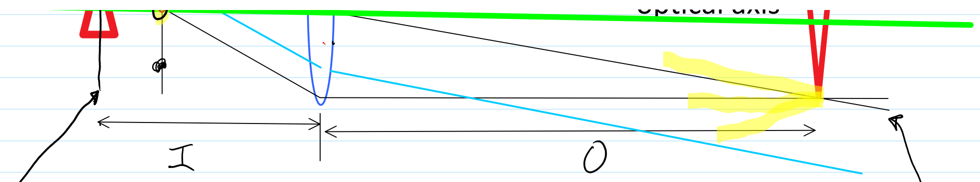


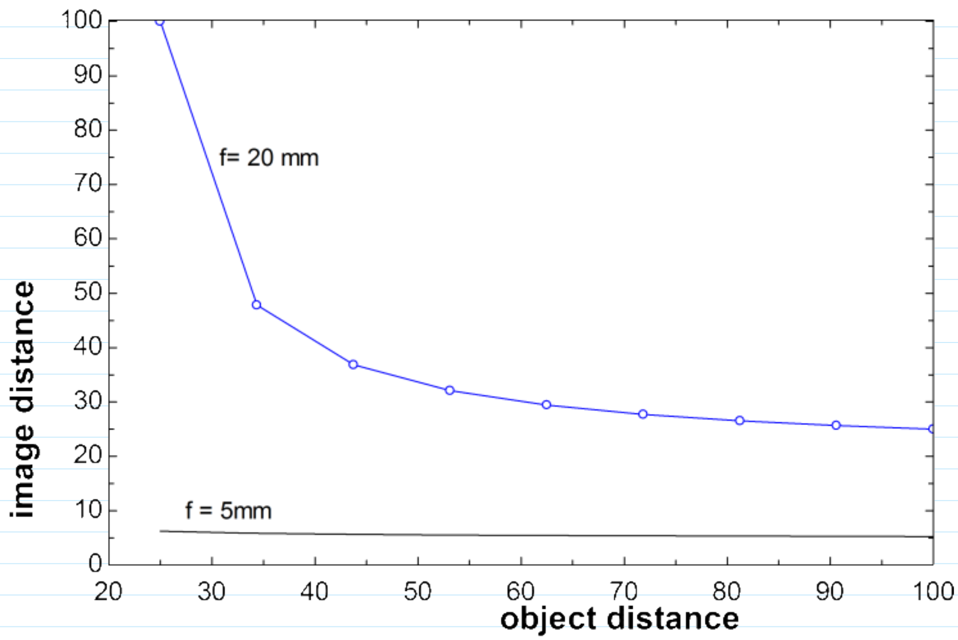
Image plane, sensor plane, FOCUS plane

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

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

As object moves closer, lens moves away from sensor plane.
Mechanical limit defines near focus distance.



This is why small cameras have better macro capability than larger cameras.

<file://C:\Users\hertzber\Documents\01CLASSES\FlowVis\Content\objectimagedistances.EES>

<u>Extension tubes</u> (for DSLR) allow lens to move further out and focus closer. $75 set of 3

"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 often lack threads. Just hold it out in front, or
mount to cardboard tube. Check focus often.
Inexpensive, $6 for set of 4

Spec'd in 'diopters' = 1/f in meters. Typically +1, +2, +4

$$\frac{1}{f_{TOTAL}} = \frac{1}{f_1} + \frac{1}{f_2}$$

PHD cameras often have 'macro mode' =
Flower Button. Does yours?

Exercise: Can you get the most magnification by zooming out and moving close, or by zooming in and moving back? At which extreme can you focus closest?

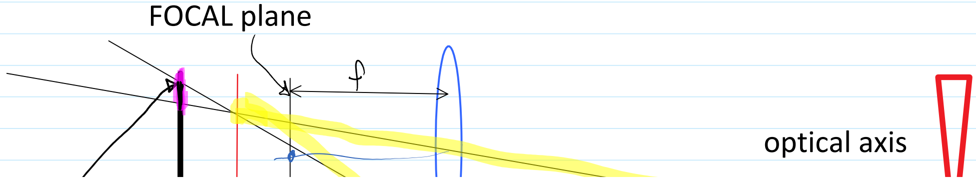
For DLSRs, prime and zoom 'macro' lenses are
available. Expect high price, hope for quality.

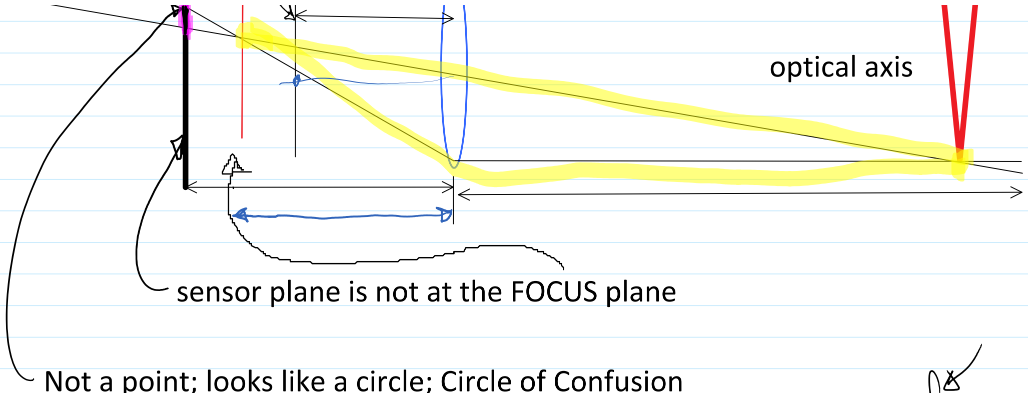
More Magnification WITH

Wide, focus close			Tight, far focus		
Cellphone	PhD	DSLR	Cell	PhD	DSlR
||	卌 |	卌			|||
3-4	2"	4-5"			5-6"
	1/2"	2-3"			

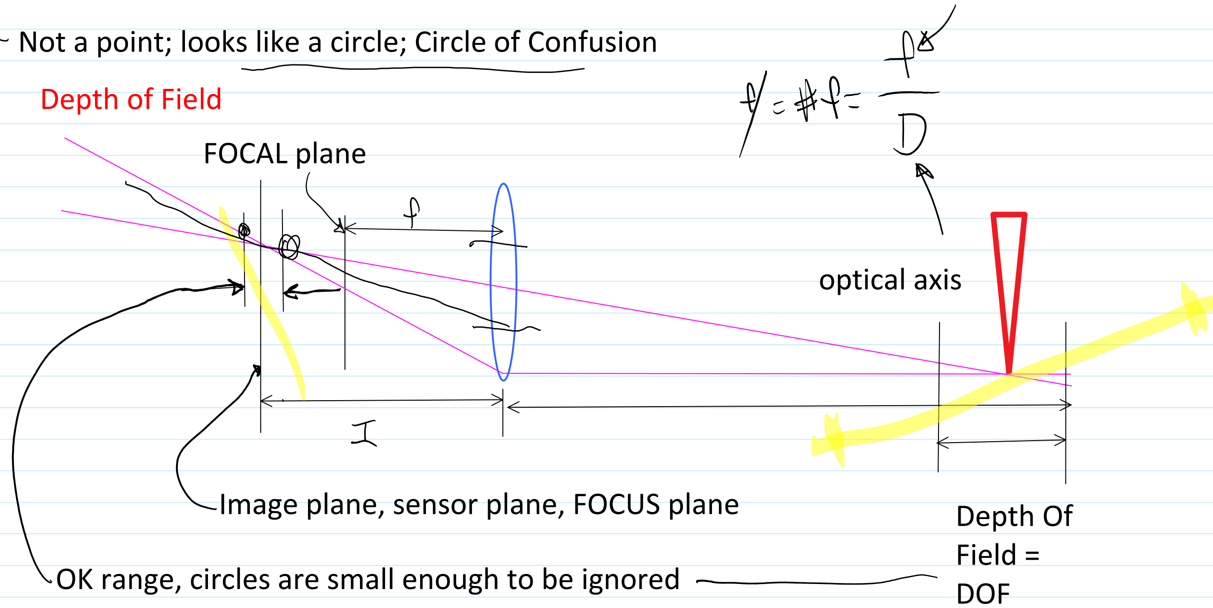
OUT OF FOCUS

FOCAL plane



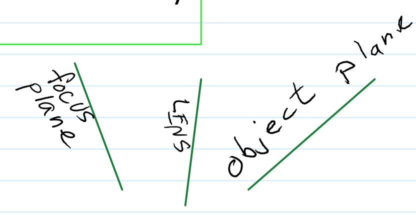


Depth of Field



LensBaby: lets you angle the lens axis compared to the camera body axis. Effectively makes the object plane not parallel to the sensor plane

http://lensbaby.com/lenses



Improve DOF by reducing diameter: smaller hole, smaller circles of confusion, better depth of field