

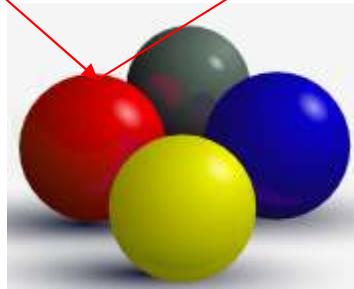
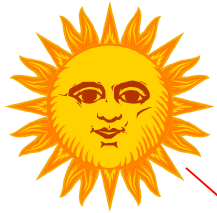
# Image Formation

Radiance: Total energy that flows from the light source (W)

Luminance: Amount of Energy an observer perceives (lumens(lm))

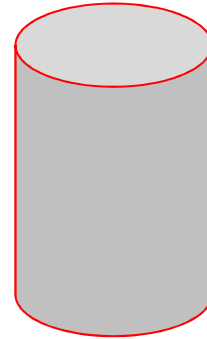
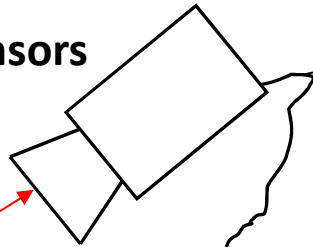
Processing and Visualization

Source of Light

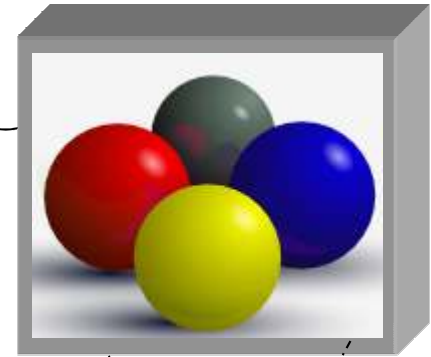


Objects

Sensors



Storage



# A simple Formation Model

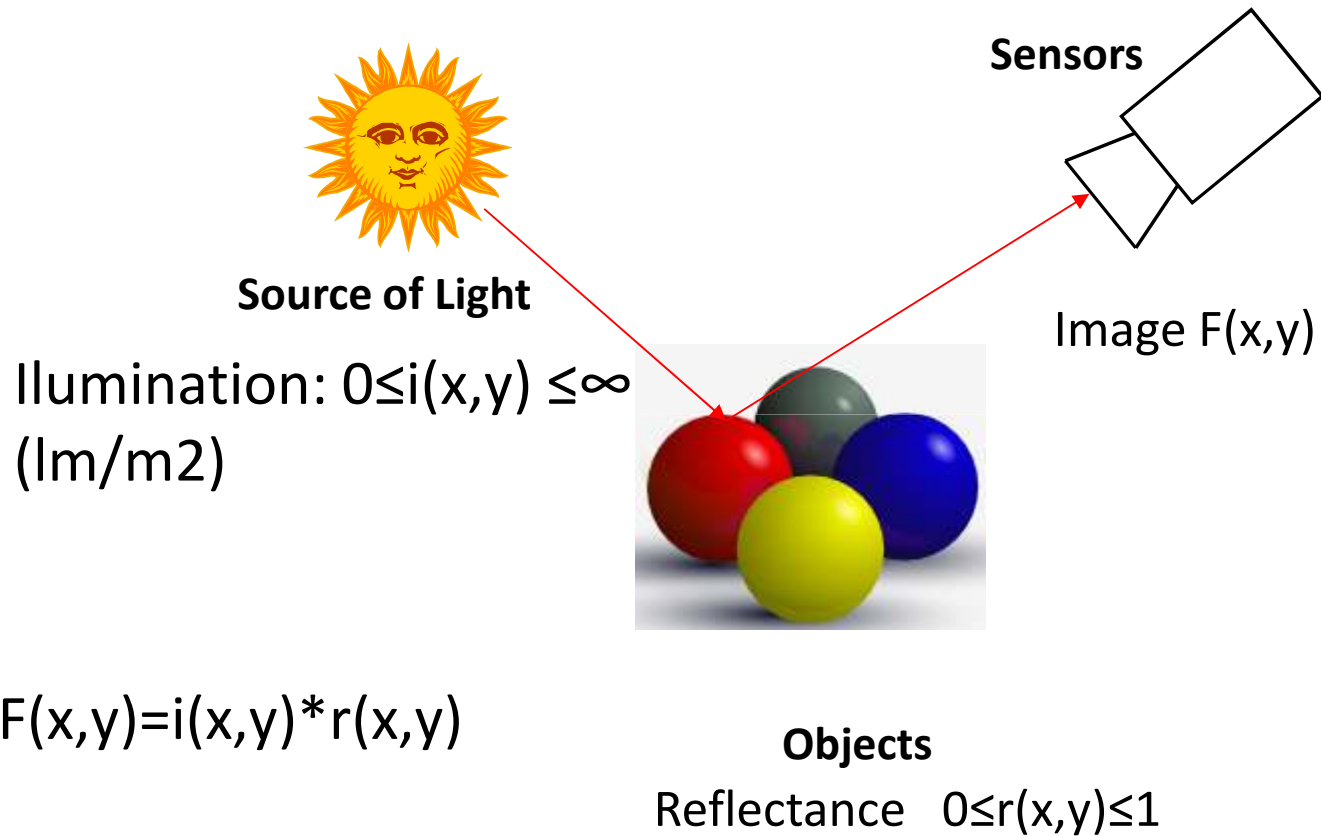
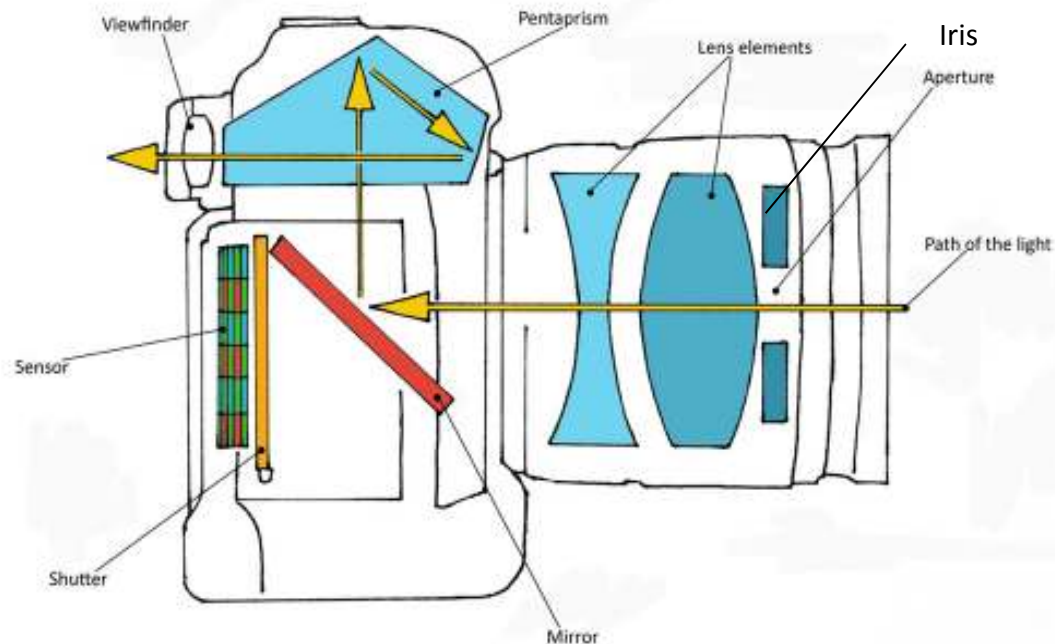


Diagram illustrating the internal components and light path of a digital SLR camera:

- Viewfinder:** The eyepiece through which the user views the scene.
- Pentaprism:** A five-sided prism that reflects light from the mirror up to the viewfinder.
- Lens elements:** The individual components of the camera lens.
- Iris:** The part of the lens that controls the amount of light passing through.
- Aperture:** The opening in the lens through which light enters.
- Path of the light:** The trajectory of light rays from the lens, through the mirror, pentaprism, and viewfinder.
- Sensor:** The image sensor that captures the light when the mirror is flipped up.
- Shutter:** The mechanism that controls the exposure time.
- Mirror:** The mirror that reflects light from the lens up to the pentaprism.

The main components of a digital camera are: Iris, lens, shutter, and sensor.

# Basics of Digital Cameras



The iris controls the aperture of the camera, determining the amount of light that reaches the sensor.

# Capturing Different Amounts of Light



1/14

Large Aperture



1/4

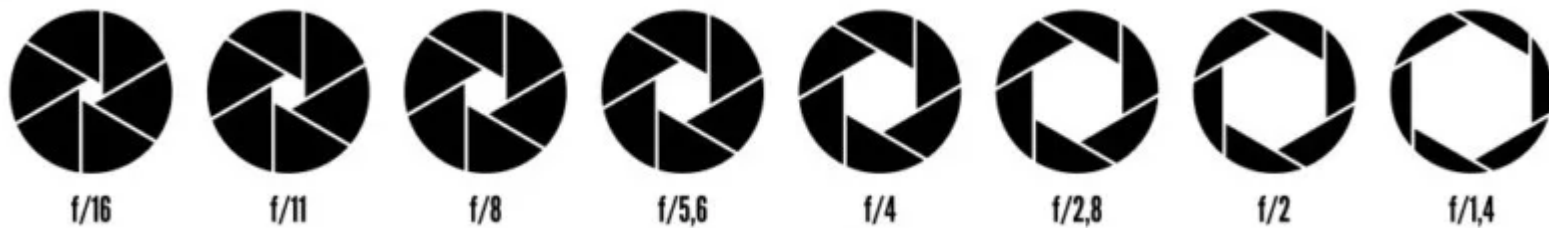
Medium Aperture



1/16

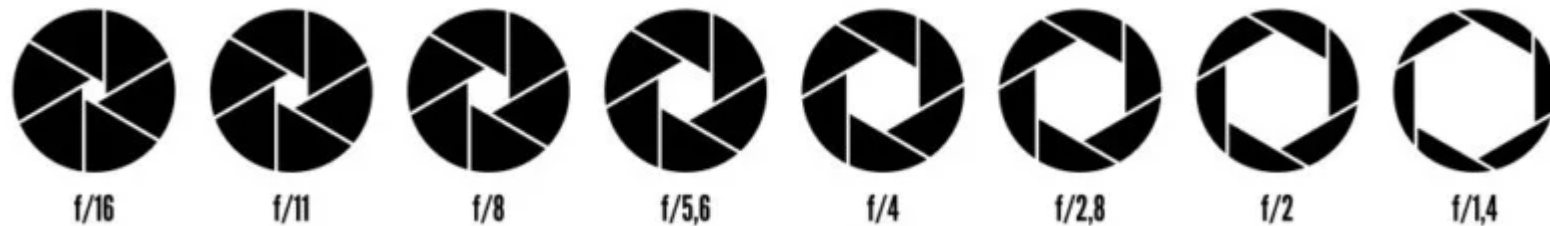
Small Aperture

# Basics of Digital Cameras



The opening of the aperture is measured using the f-number (f-stop); the diameter of the aperture is determined by the focal length divided by f-stop number.

# Basics of Digital Cameras



Calculate the diameter of the aperture if we are using lens with focal length of 50 mm and aperture of f/2.8.

What about an aperture of f/1.4?

$$Area_{f/2.8} = \pi * (50 / (2.8 * 2))^2 = 250.44mm^2$$

$$Area_{f/1.4} = \pi * (50 / (2 * 1.4))^2 = 1001.54.44mm^2$$

There is a difference of two stops between f/1.4 and f/2.8.



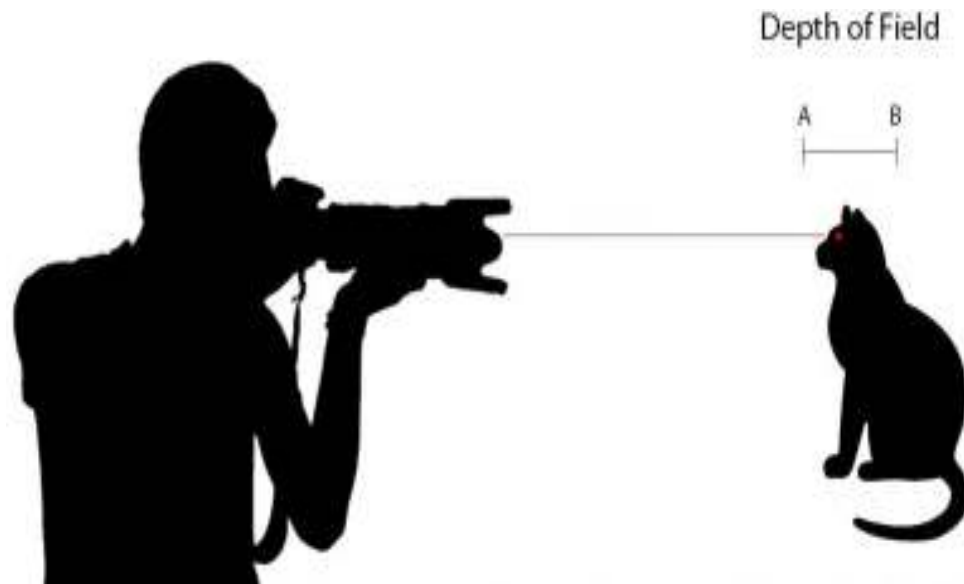
Shallow depth of field (large aperture)



Large depth of field (small aperture)

The opening or closing of the iris (aperture) also controls the **depth of field**, it refers to the amount of the image that is sharp.





Smaller Depth of Field(shallow)



Some common values for portrait images:  
f/1.4, f/2, or f/2.8



Larger Depth of Field

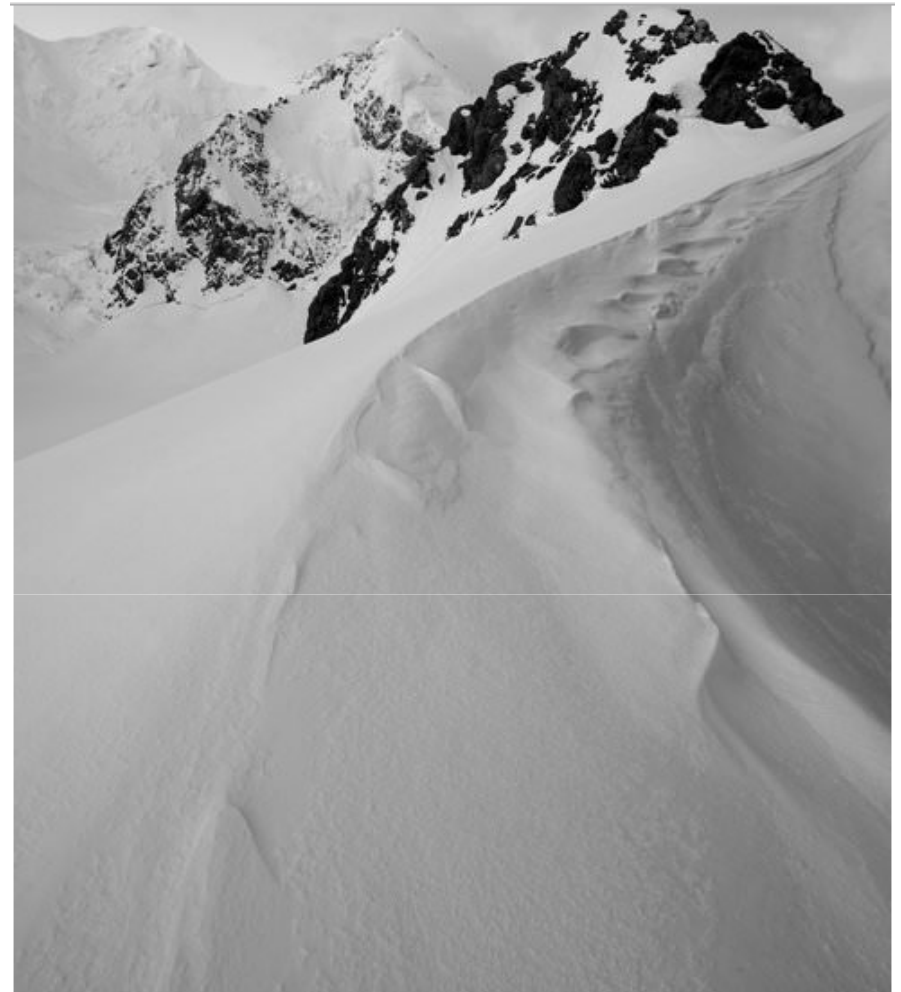


Some common values for landscape  
images: f/8, f/11, or f/16





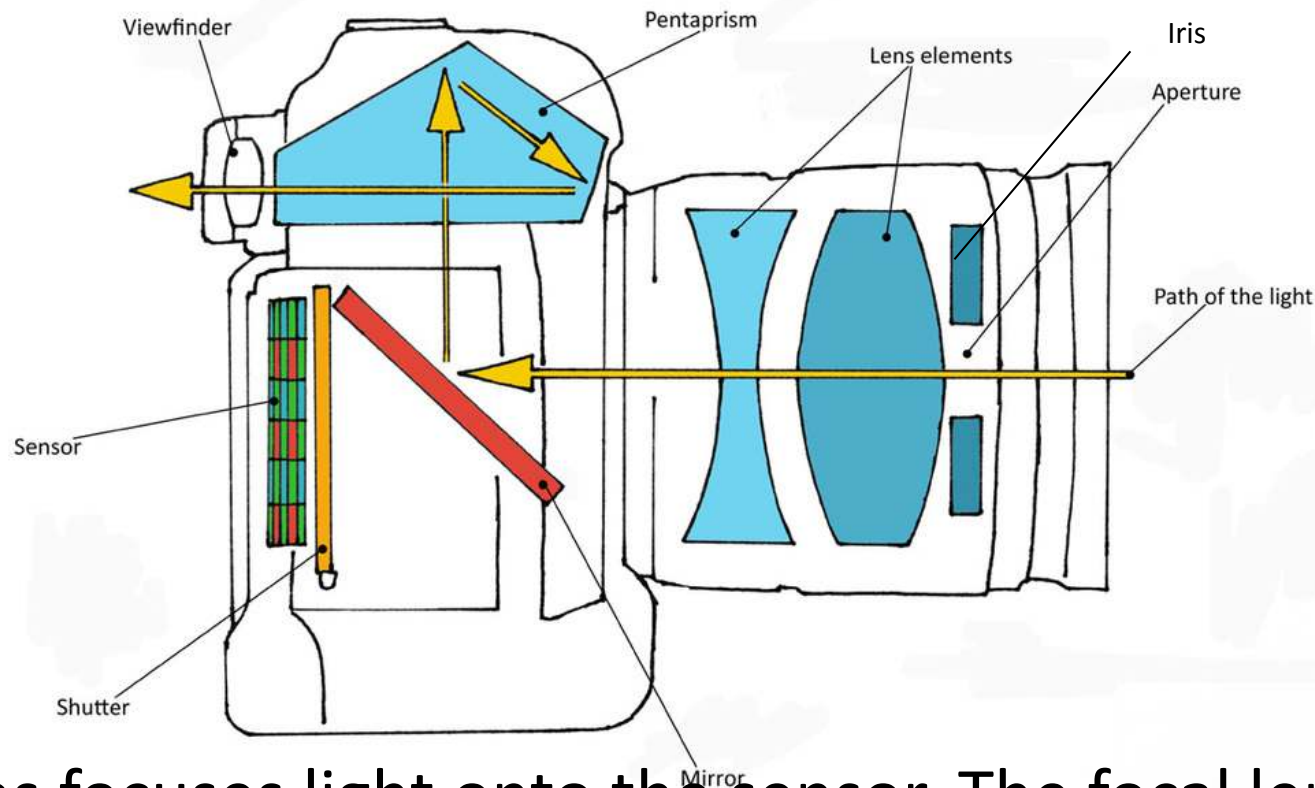
Some common values for portrait images:  $f/1.4$ ,  $f/2$ , or  $f/2.8$



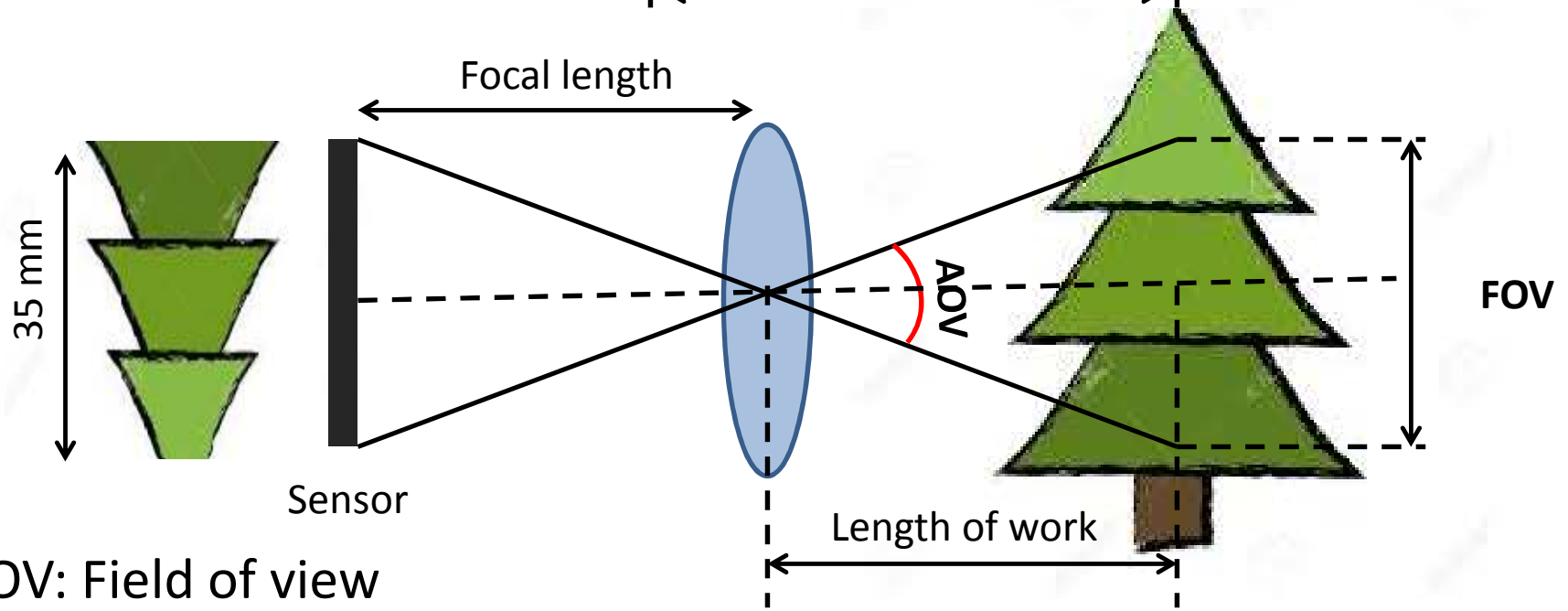
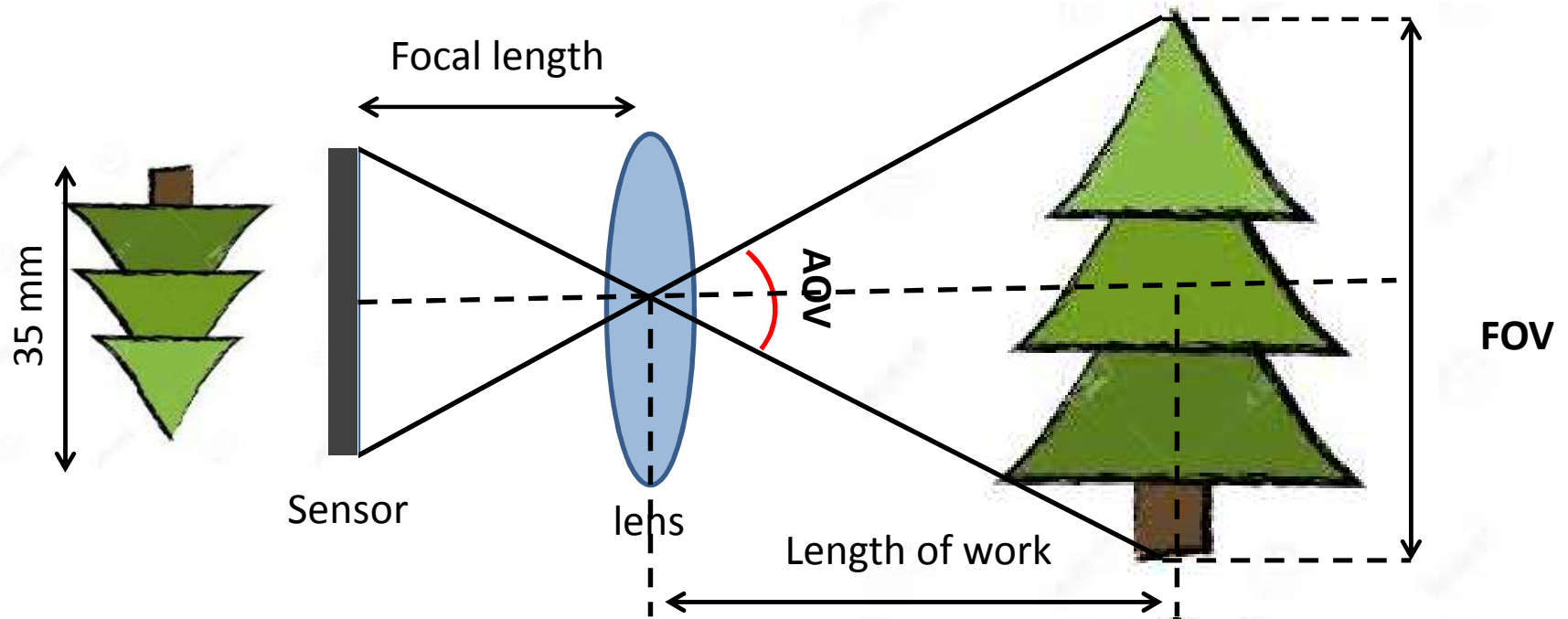
Some common values for landscape images:  $f/8$ ,  $f/11$ , or  $f/16$



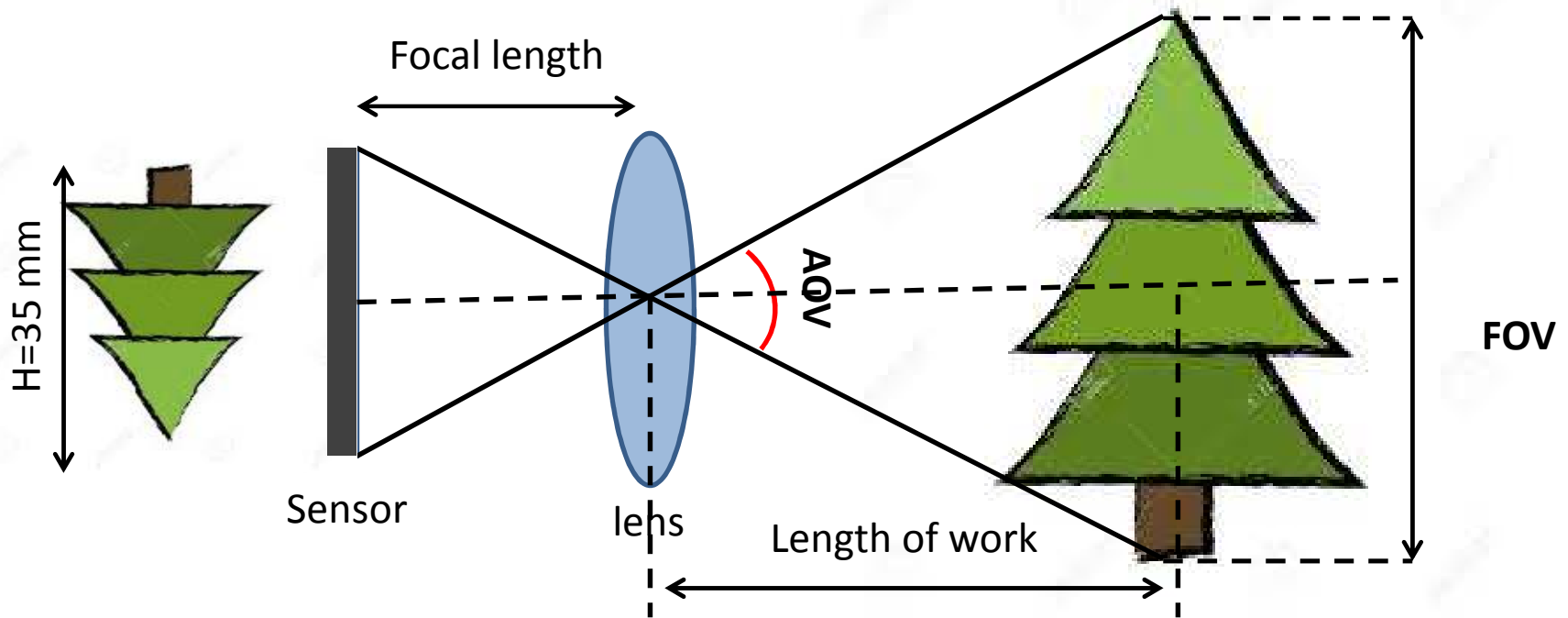
# Basics of Digital Cameras



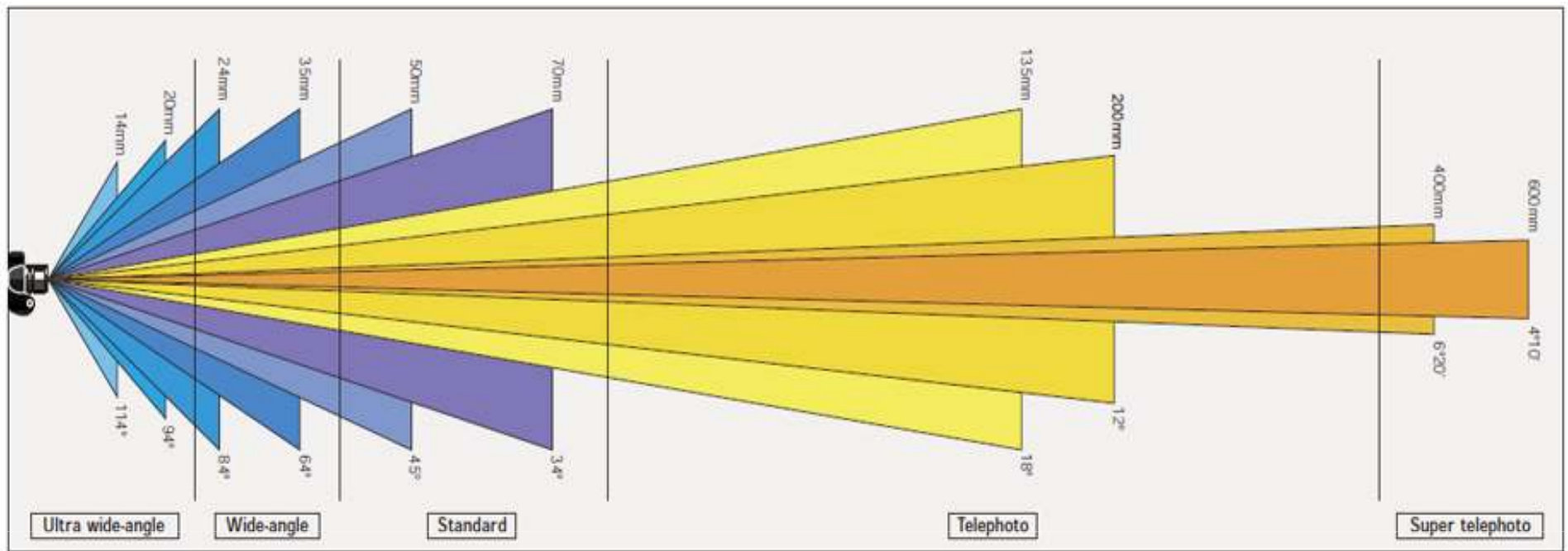
The lens focuses light onto the sensor. The focal length is the distance from the point where all the light rays converge inside the lens (optical center) to the sensor .



FOV: Field of view  
AOV: Angle of view



$$\frac{H}{\text{Focal Length}} = \frac{FOV}{\text{Length of work}}$$

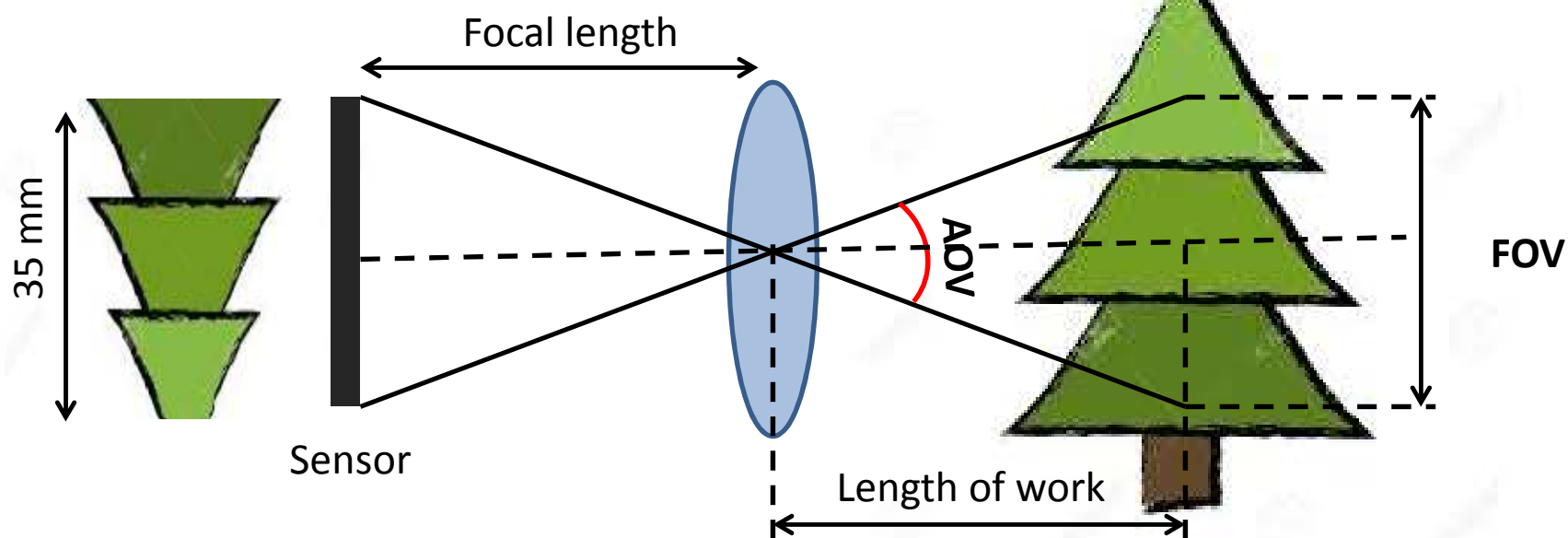
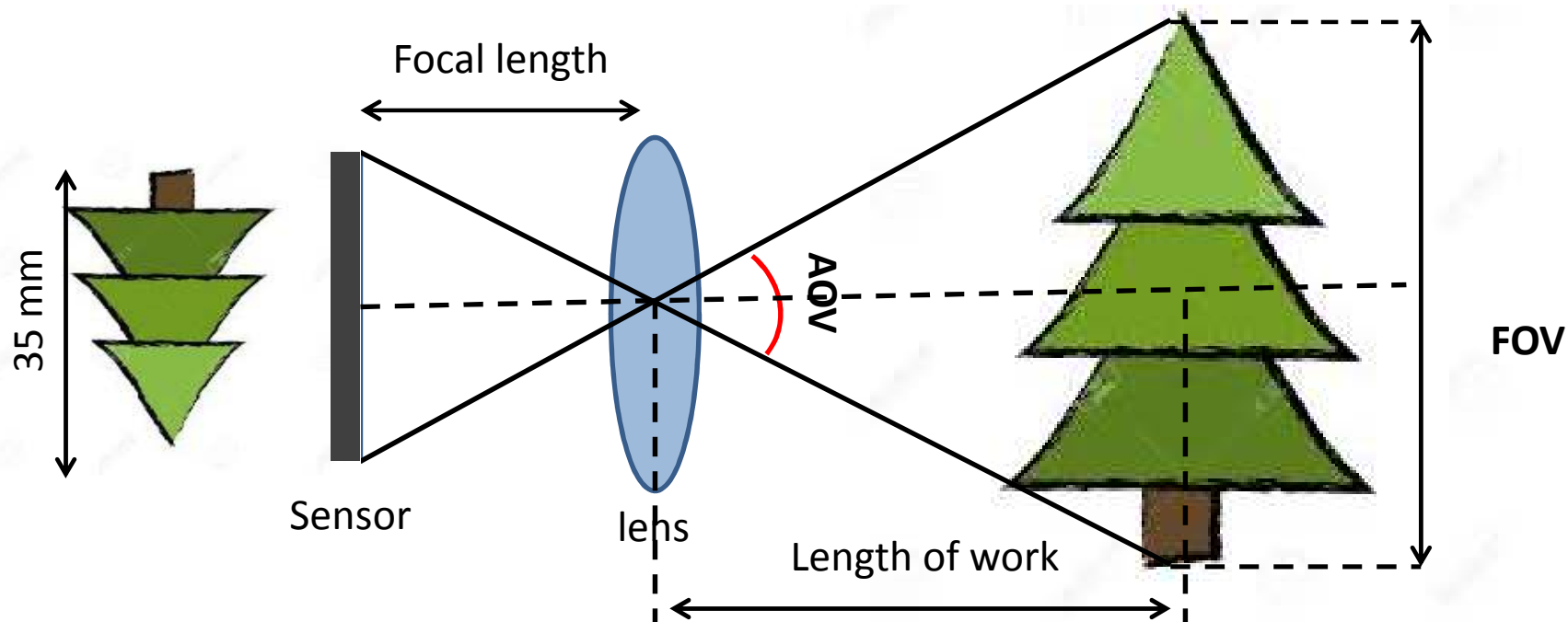


Focal length ↑

AOV ↓

Magnification ↑





Focal length ↑      AOV ↓      Magnification ↑



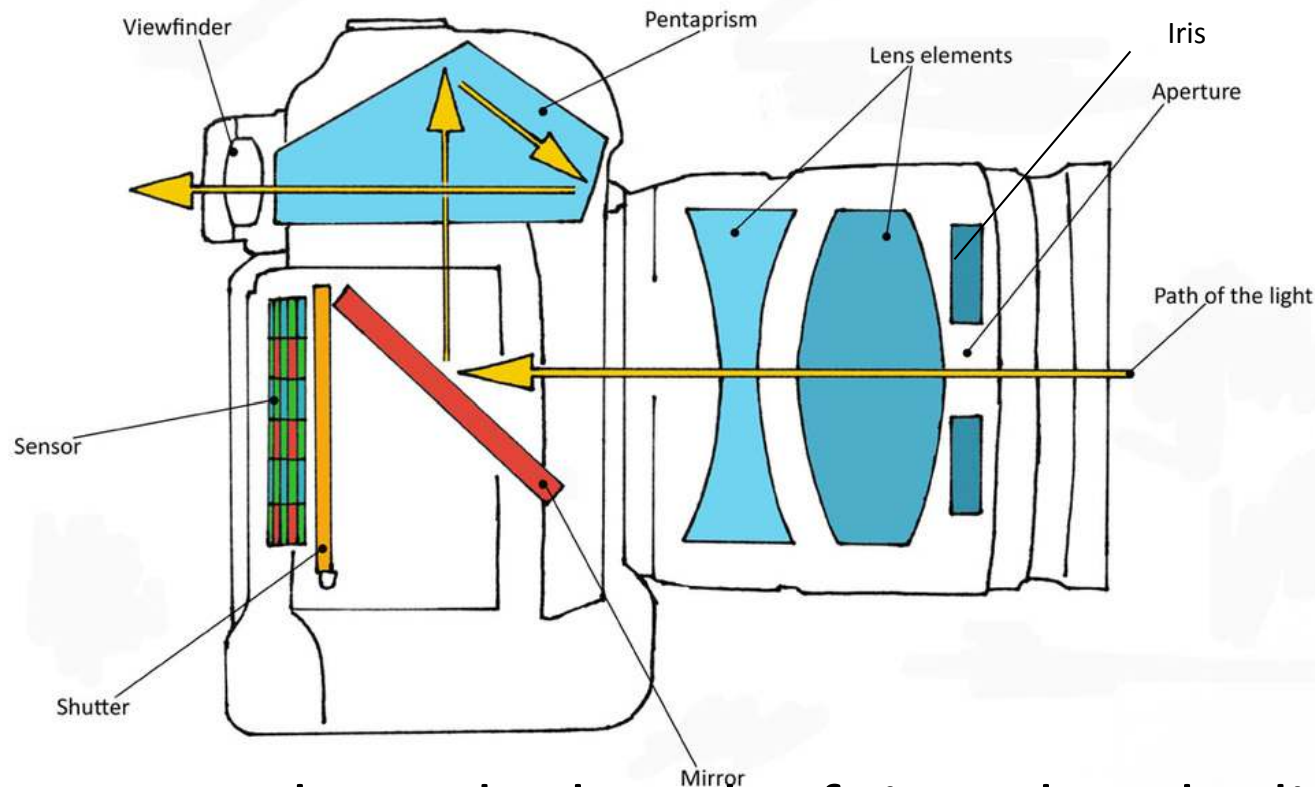
Focal length ↑

AOV ↓

Magnification ↑



# Basics of Digital Cameras



The shutter regulates the length of time that the light is admitted through the lens to the sensor (shutter speed). The shutter speed can be as fast as 1/10,000 of a second or as slow as several minutes.

# Capturing Different Amounts of Light



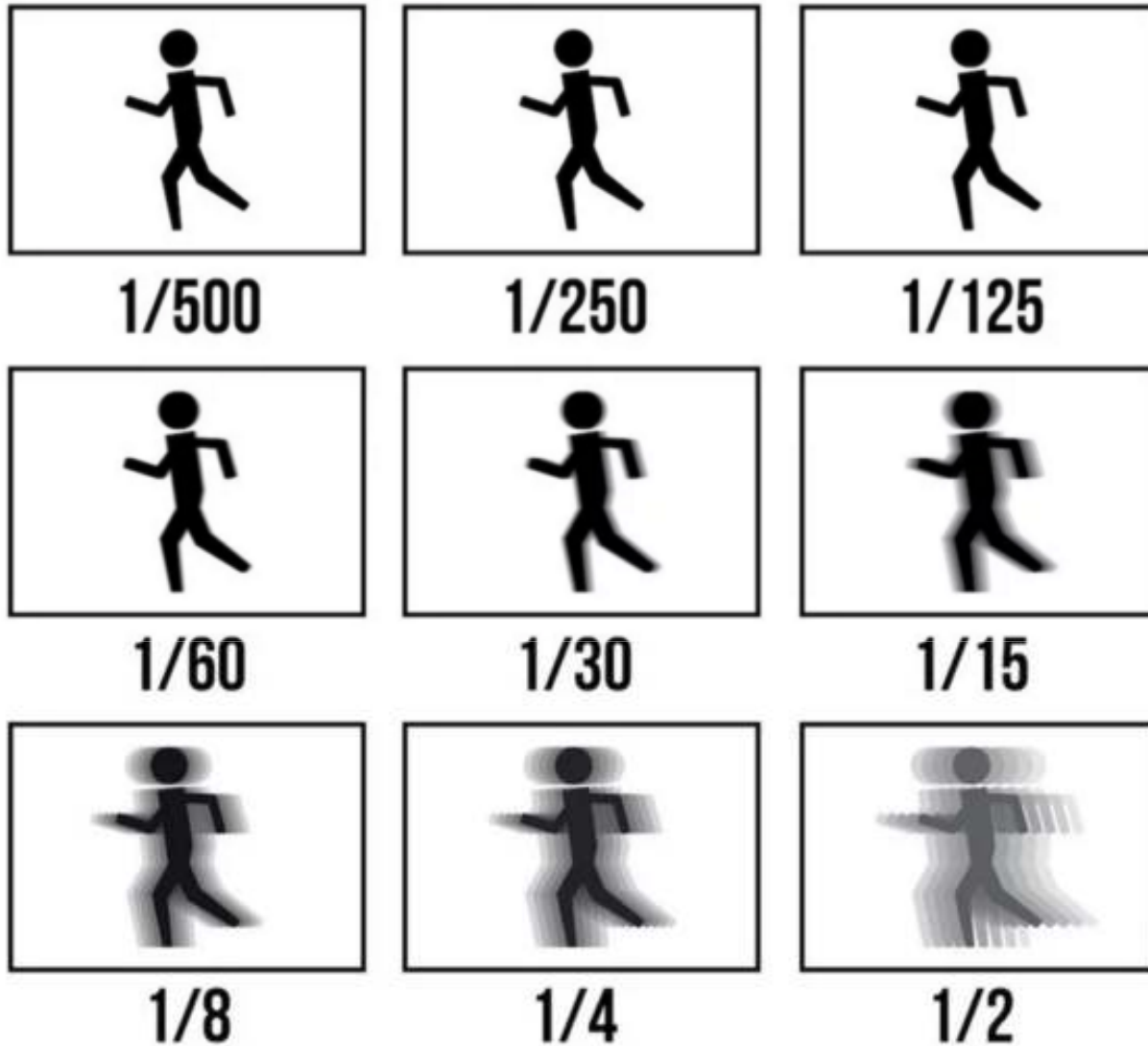
Low  
shutter speed



Medium  
shutter speed



High shutter  
speed



Fast shutter speeds have the effect of freezing motion in the scene. Conversely, slow shutter speeds will blur motion in a scene.

# Shutter Speed



1/500 sec



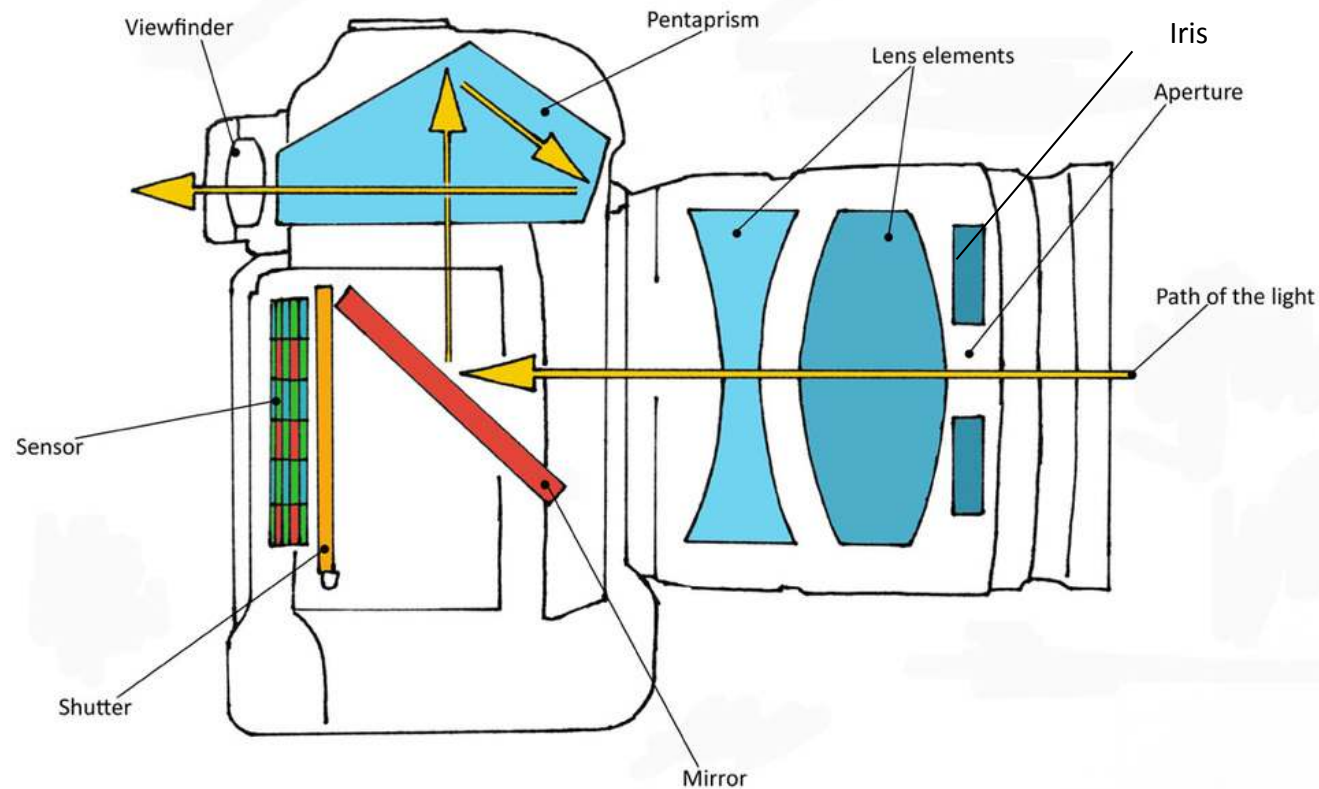
1/8 sec

# Shutter Speed



90 sec

# Basics of Digital Cameras



# Image Sensing

Incoming energy (e.g. light) lands on a sensor material responsive to that type of energy, generating a voltage. Collection of sensors are arranged to capture images.

