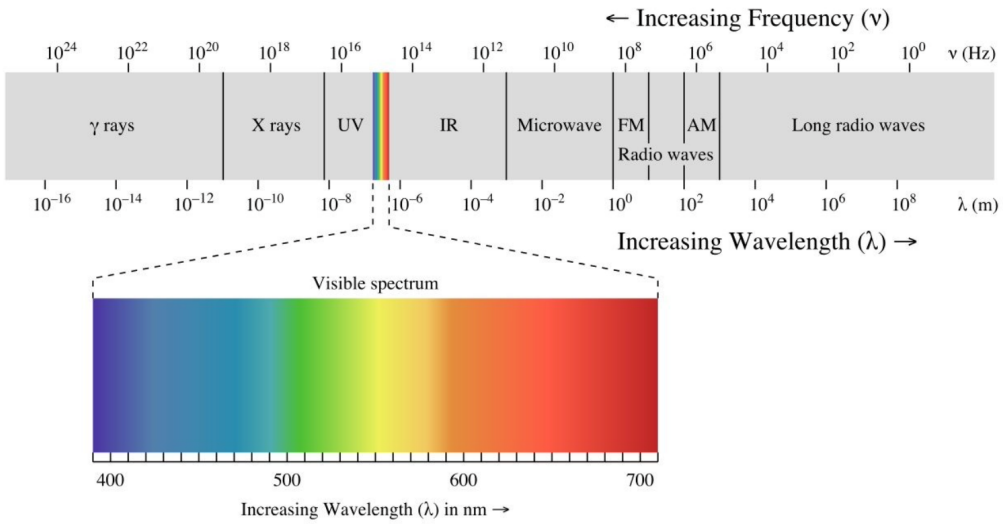
Chapter 1 Summary

Electromagnetic Spectrum
Types of Sources
Wave Motion
Electromagnetic Waves
Longitudinal Waves
Polarization
Ultraviolet Light
Wavefronts, Waves, &Rays
Rectilinear Propagation

The Electromagnetic Spectrum



(https://leadertechinc.com/basics-electromagnetic-spectrum)

Visible Light Spectrum

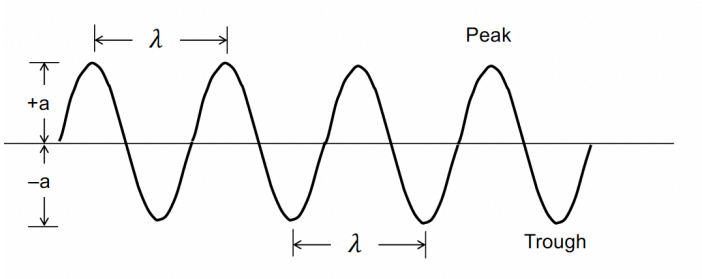
Ultraviolet	<350nm
Blue	350nm
Yellow	550nm
Red	750nm
Infrared	>750nm

Types of Sources

Point Source
Extended Source
Monochromatic Source
Polychromatic Source

Wave Motion / Wave Definitions

Wavelength (λ) distance from peak to trough (for light, measured in nanometers (nm))
Amplitude (A) amount of displacement related to intensity



(From Dr. Loshin's course notes)

Frequency (f) number of cycles per time unit (measured in Hertz (Hz))
Period (P) reciprocal frequency
Velocity (v) speed (measured in meters per second (m/s))

Speed of Light in a Vacuum (or air) = 3.0×10^8 m/s

Relevant Equations

The relationship between velocity, frequency, and wavelength: $v = f\lambda$

Polarization of Light

Definitions:
Unpolarized: random vibrations normal to direction of travel
Polarized: (transverse waves) vibrations are limited to specific plane or planes
Plane Polarized: vibrations limited to one plane

Ultraviolet Radiation

Source of concern as it is associated with cataracts and possibly macular degeneration. Causes sunburn and photokeratitis.

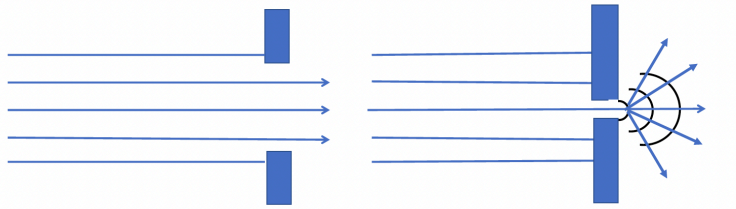
Wavefronts

Law of Malus: rays are perpendicular to wavefronts

By convention, light travels from left to right (important in assignment of signs)

Rectilinear Propagation of Light

Light travels in straight lines
Pinhole Diffraction: light emerging from a small aperture will change direction



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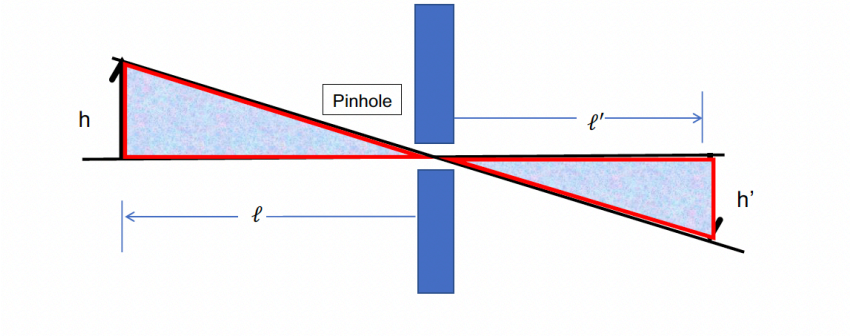
Pinhole Camera



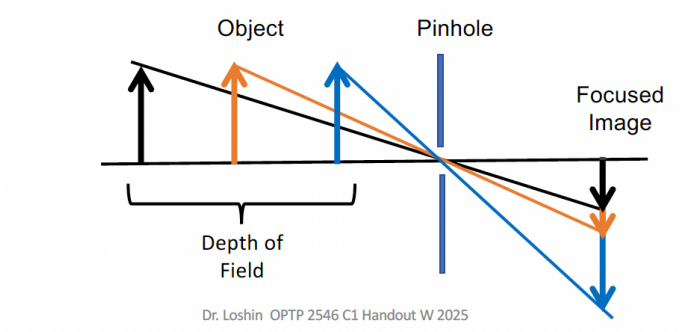
(From Dr. Loshin's course notes)

Relevant Equations
Remember rules of similar triangles when solving problems

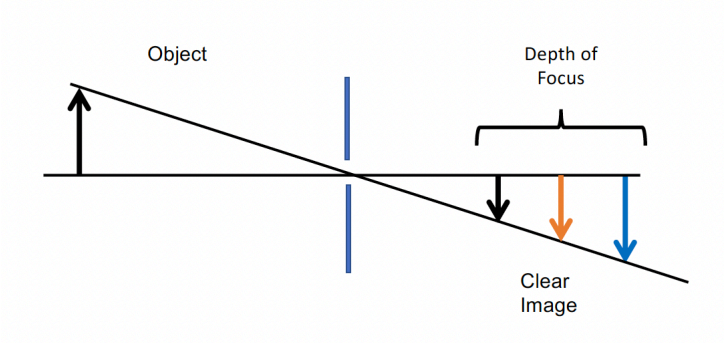
Similar Triangles Sides are Proportional	$\frac{h'}{h} = \frac{\ell'}{\ell}$

(From Dr. Loshin's course notes)
Depth of Field & Depth of Focus

Depth of Field: the range over which an object can be moved and maintain a clear image



Depth of Focus: the range over which the image screen can be moved and maintain a clear image



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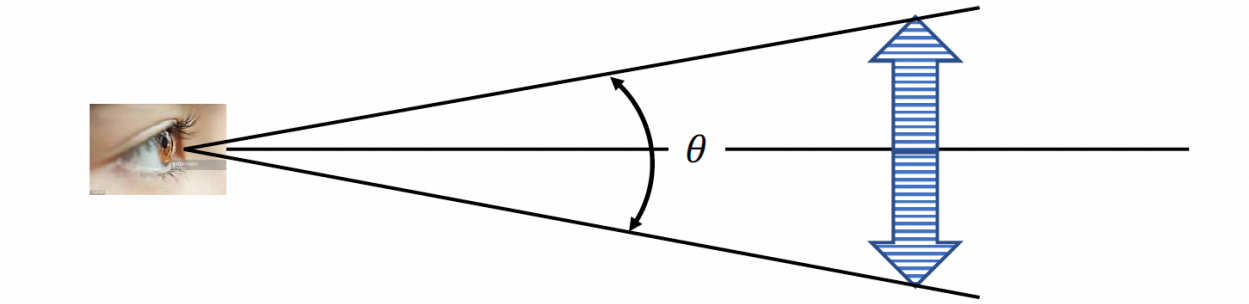
Field of View: angular extent an object can be viewed



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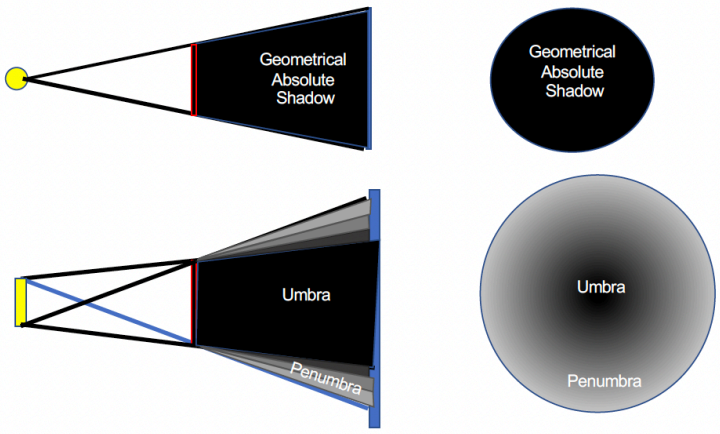
Shadows and the Propagation of Light

Shadows & Obstruction of Light

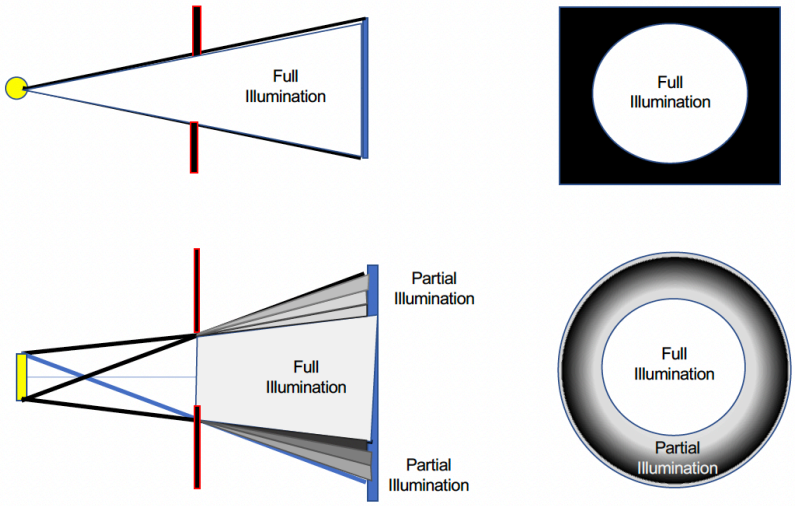


Shadow – light restricted by an opaque obstacle

Point source
- Geometrical or absolute shadow with clearly defined outer edges

Extended Source
- Umbra **inner** absolute region completely dark
- Penumbra **outer** annular varying from dark to light

Full & Partial Illumination



Region of Illumination
illumination passing through an aperture and fall on a screen

Full Illumination
- Center uniform light region

Partial Illumination
- Outer annulus which varies from center light to dark

Chapter 1 Additional Problems

Problem Types

1. Relationship between frequency, wavelength, and velocity of light

2. Pinhole camera (object and image distances and sizes)

3. Shadows and obstruction of light (point and extended sources)

4. Full and partial illumination (point and extended sources)

The relationship between frequency, wavelength, and velocity of light

Remember: $v = f\lambda$
The velocity of light in air (or vacuum) is 3.0×10^8 m/s
The frequency of a wave is constant for all media

1. What is the frequency of light that has a wavelength of 750nm in air?

2. The light in the previous problem is transmitted through an optical media that has slows the velocity to 2.0×10^8 m/s. What is the wavelength of the light in this media?

Pinhole Camera (object and image distance and size)

Remember: use similar triangles
$\frac{h'-h}{l'-l}$

1. A pinhole camera is used to create an image of an object that is 20cm tall. If the object is 100cm in front of the pinhole and the image created of it is ¼ of the object's size, what is the distance from the pinhole to the screen (film plane)?

2. A pinhole camera produces an image 2.25 inches in diameter of a circular object. When the screen is moved 3 inches farther from the pinhole, the image increases to 2.75 inches in diameter. What was the original distance from the pinhole to the screen?

Shadows and obstruction of light (point and extended sources)

Remember: a point source produces a sharp uniform shadow
An extended source produces an umbra (total shadow) and penumbra (partial shadow)

1. Find the size of the shadow created by a point source of light and a 2m diameter opaque disk if the screen is 20m from the light and the disk is 10m from the screen.

2. The point source in the previous problem is replaced with an extended source 1m in diameter. What is the width of the penumbra formed?

Full and partial illumination (point and extended sources)

Remember: a point source produces a sharp region of full illumination
An extended source produces an area of full illumination and an area of partial illumination

1. What is the diameter of the circle illuminated on a screen 15m from a point source of light if the light travels through an aperture (located 5m from the light source) that is 1m in diameter?

2. The point source in the previous problem is replaced with an extended source 50cm in diameter. What is the diameter of the area of full illumination?