Recitation 3

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Midterm 1 Review

Review: What you've done these past weeks

Match the Model to the Phenomena

$$\#\ \text{bright fringes} = 2m + 1$$

$$m\lambda = d\ sin\theta$$

$$2t = (m + 1/2)\lambda_{film}$$

$$\#\ \text{bright fringes} = 2p - 1$$

$$n = \frac{c}{v}$$

$$2t = m\lambda_{film}$$

$$v = f\lambda$$

$$n_i sin\theta_i = n_t sin\theta_t$$

$$\lambda_{oil} = \frac{\lambda_{air}}{n}$$

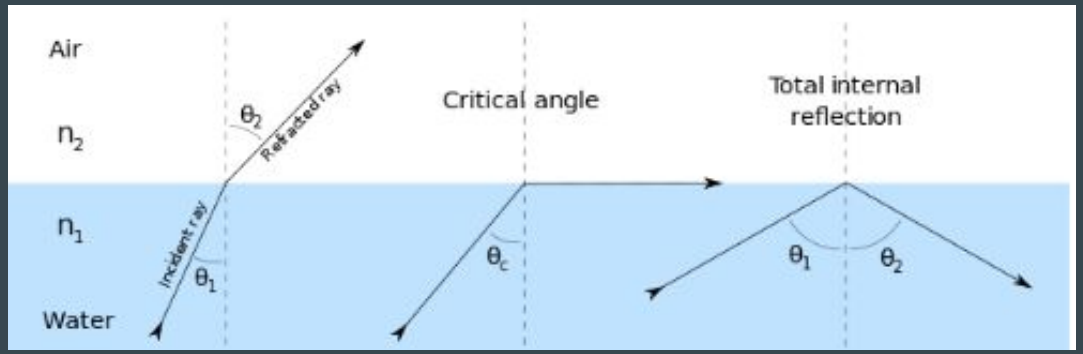
$$Dsin\theta = m\lambda$$

$$a \sin\theta_p = p\lambda$$

A. Index of refraction
B. Velocity of light in a medium
C. Snell's Law
D. Constructive interference for a thin film with no phase difference
E. Constructive interference for a thin film with a phase difference of Pi
F. Wavelength of light in an oil/film
G. Constructive interference for double slit
H. Constructive interference for a single slit
I. Constructive interference for a diffraction grating
J. # bright fringes for a diffraction grating/double slit
K. # bright fringes for a single slit

Total Internal Reflection

- Two Conditions
  - Light travelling from a higher n to a lower n (like water to air)
  - The angle of incidence is equal to or greater than the critical angle



$$\text{if } n_1 > n_2$$

$$sin(\theta_c) = \frac{n_1}{n_2}$$

Dispersion

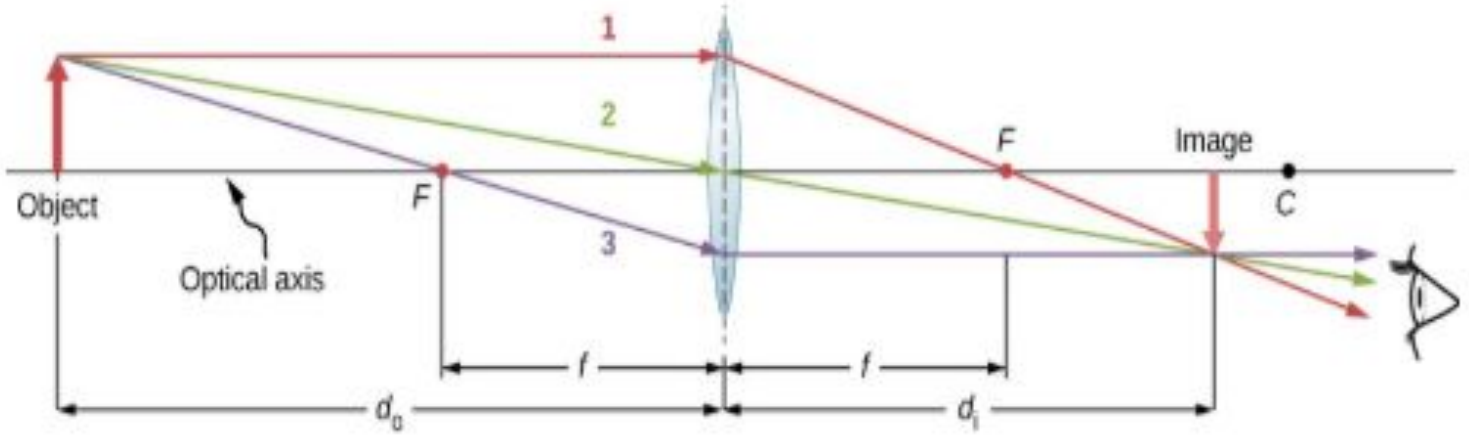
- Different wavelengths travel at *slightly* different velocities through a medium
- Doesn't affect large wavelengths much in general
- Large effect on shorter wavelengths
- Violet is a smaller wavelength -> bends more
- Red is a longer wavelength -> bends less

Thin Lens - Converging Lens

1. Parallel to the optical axis and refracts through the far focal point

2. Straight line through center of optical element

3. Through the near focal point, refracts parallel to the optical axis

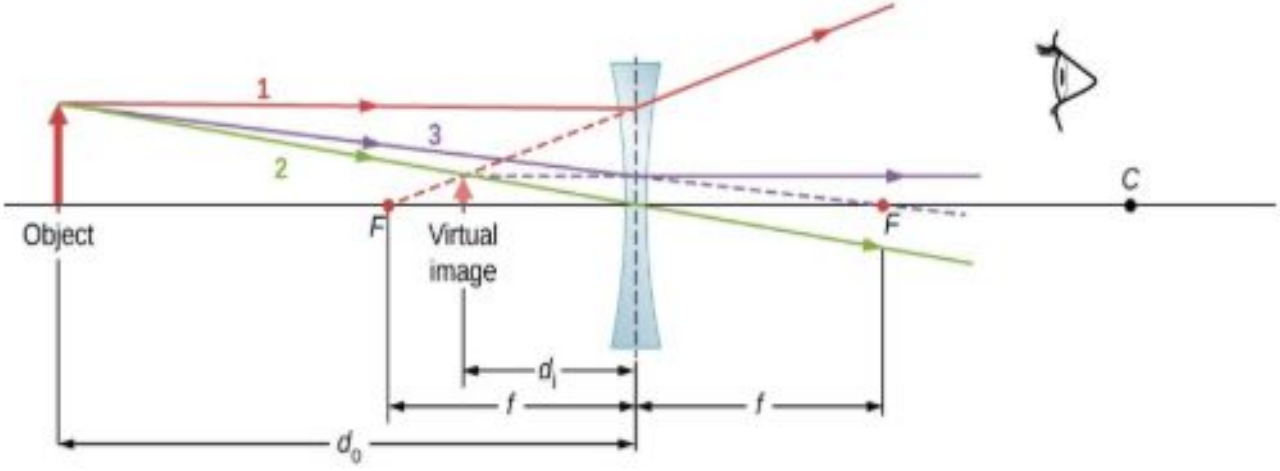


Thin Lens - Diverging

1. Parallel to the optical axis and refracts through as if came from near focal point

2. Straight line through center of optical element

3. Towards far focal point, refracts parallel to the optical axis



Helpful Equations

- The radius of curvature of a lens is equal to twice the focal length

$$2f = R$$

- The focal length is related to the image distance and the object distance

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

- The magnification of an image is given by

$$m = -\frac{d_i}{d_o}$$

Remember that....

- The focal length of a diverging lens is always negative
- Zero on the x-axis is set at the center of the lens
- A negative magnification means the image is flipped upside-down
- Virtual objects are formed by tracing back the rays hitting the observer's eye
- The image distance for an unimpaired eye is 24 mm
- The near point is the closest distance at which your eye can focus on something
- If something is far away, the object distance is ∞

Practice Problem/AMA

S18 Midterm 1

2. A diffraction grating with slit spacing of 10 slits per mm is made of individual slits of width 10 μm. Each individual slit creates a diffraction pattern, as does the diffraction grating as a whole. Compare the width of the central maximum due to the individual slits, $W_{individual}$, with the width between maximums of the diffraction pattern from the grating, $W_{grating}$.

- ☐ a) $W_{individual} = 20W_{grating}$
- ☐ b) $W_{individual} = 5W_{grating}$
- ☐ c) $W_{individual} = 2W_{grating}$
- ☐ d) $W_{individual} = \frac{1}{2}W_{grating}$
- ☐ e) $W_{individual} = \frac{1}{5}W_{grating}$
- ☐ f) $W_{individual} = \frac{1}{20}W_{grating}$
- ☐ g) Can't solve exactly because these are not small angles

Two Converging Lenses Problem

Two converging lenses, with focal length f1 = 10 cm and f2=15cm are placed 40 cm apart. An object is placed 60 cm in front of the first lense.

a. Find the position of the final image formed by the combination of the two lenses
b. Find the magnification of the final image formed by the combination of the two lenses

S18 Final

13. (8 points) A toy dinosaur is 10 cm to the left of an optical element (lens or mirror). The image of the dinosaur appears 20 cm to the right of the optical element. Both the toy dinosaur and its image appear right side up.

a) (6 points) What type(s) of optical element(s) (Converging Lens, Diverging Lens, Concave Mirror, Convex Mirror, or Plane Mirror) could create such an image? Find the focal length of the optical element(s). Explain (briefly!) your reasoning for full credit.

b) (2 points) For the possible optical element(s) you found, is the image a real or virtual image? How do you know? (if you found more than one element, give the image type for each)