Introduction to Physical Science

Image Formation - Lenses

Presented by Robert Wagner

Dispersion

- The spreading of white light into its full spectrum of wavelengths
- Refraction is responsible for dispersion in things like rainbows
- The index of refraction (n) depends on wavelength
- Rainbows are produced by a combination of reflection and refraction

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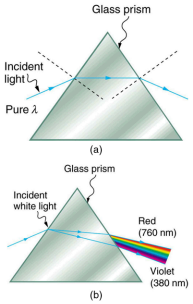

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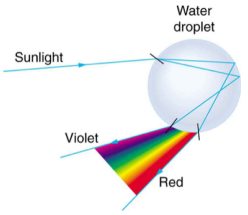

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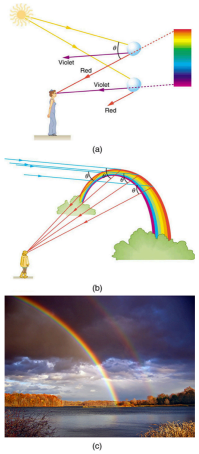

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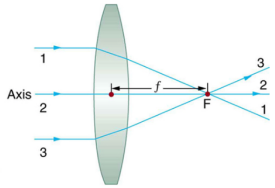
Lenses

- Convex lens - converging lens - rays are bent toward the axis
- Concave Lens - diverging lens - rays are bent away from the axis
- The focal point of a lens is the point at which the rays cross
- The focal length of the lens is the distance from the center of the lens to its focal point
- The power of a lens is the inverse of its focal length
-



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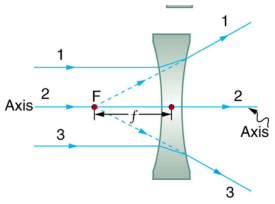

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Example

- If a magnifying glass is found to concentrate sunlight to a small spot 8.00 cm away from the lens. What are the focal length and power of the lens?
  - Draw a sketch (if applicable)
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

$$d = 8.00\ cm = 0.0800\ m$$

$$f = 8.00\ cm$$

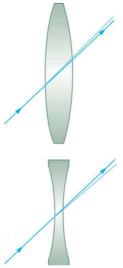
$$P = \frac{1}{f} = \frac{1}{0.0800\ m}$$

$$P = 12.5\ m^{-1} = 12.5\ D$$

D is the diopter, a measure of optical power

Ray Tracing and Thin Lenses

- Thin lens - lens that is thin enough that no dispersion occurs and thin enough that a ray through the center is undeviated
- A thin lens is an ideal concept of a lens where we can consider that the light bends only once



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Rules for Ray Tracing

- A ray entering a converging lens parallel to its axis, passes through the focal point
- A ray entering a diverging lens parallel to its axis seems to come from the focal point
- A ray passing through the center of a converging or diverging lens does not change direction
- A ray entering a converging lens through its focal point exits parallel to its axis
- A ray that enters a diverging lens by heading toward the focal point on the opposite side exits parallel to its axis

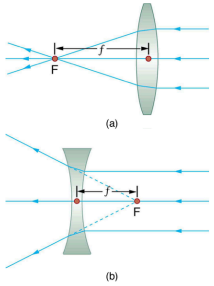

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Image Formation

- Use rules for thin lenses
- Since we are looking at the rays from the person's head, they intersect at the image of the person's head
  - Real image - light rays actually cross at the image location and can be projected (on a screen, for example)

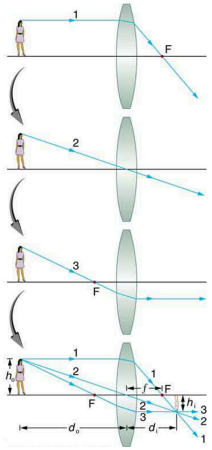

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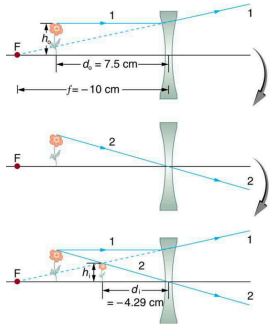
Image Formation (2)

- Use rules for thin lenses
- Since we are looking at the rays from the top of the flower, they intersect at the image of the top of the flower
  - Virtual image - light rays do not actually cross at the image location and can not be projected (on a screen, for example)



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Summary

- Dispersion is the spreading of light into its component wavelengths
- Lenses can be converging or diverging
- A thin lens allows us to consider the light to bend only once and to use ray tracing rules