

Physics 102

Lecture 26

Wed. Nov. 10, 2004

• Ray Tracing for thin Lenses (for small angle)

① P-ray

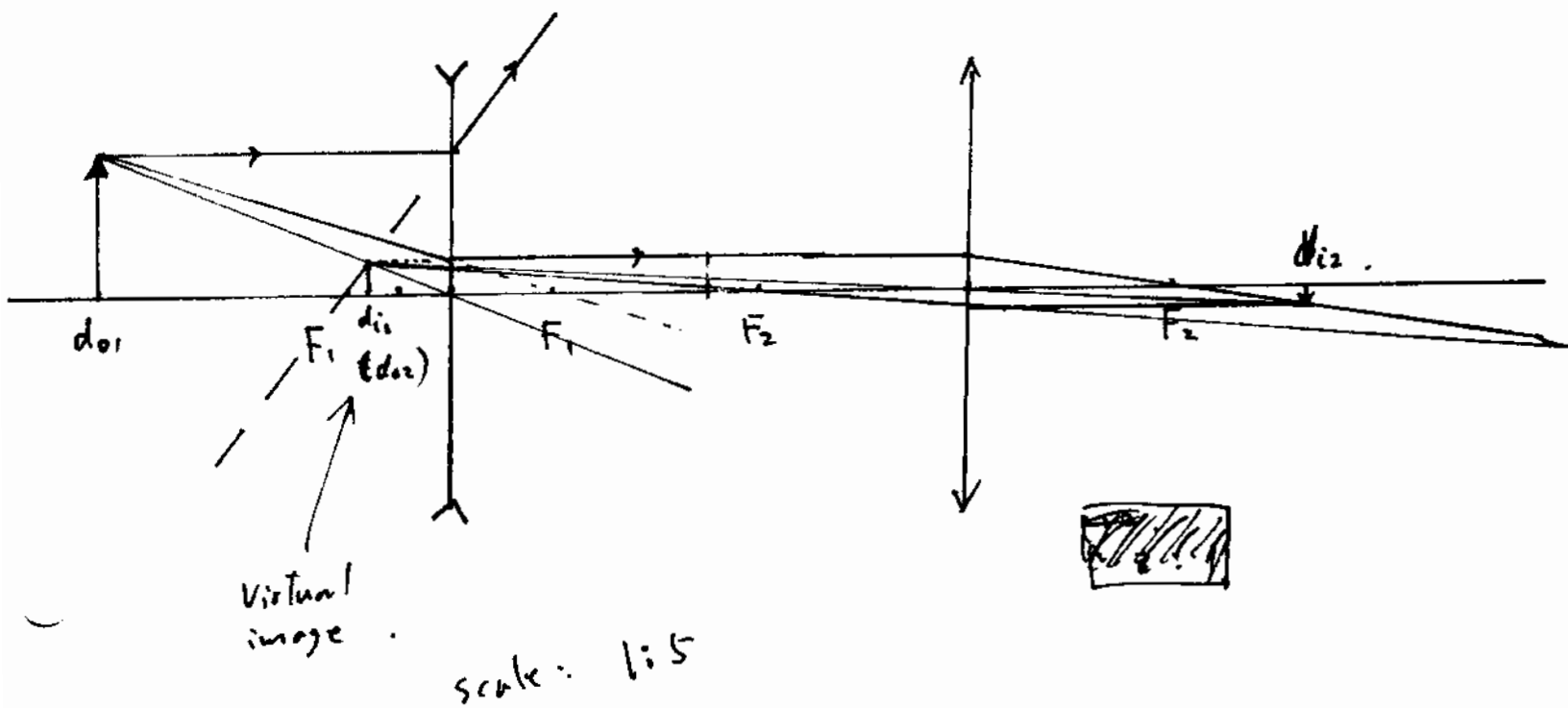
② F-ray

③ M-ray (Midpoint ray) — No bending!

e.g. Ch. 26. #62. p. 885.

2 lenses: $f_1 = -7.0$ cm, $f_2 = 14$ cm 35 cm apart

The object is placed 24 cm to the left of lens 1.



• Then thin lens Equation

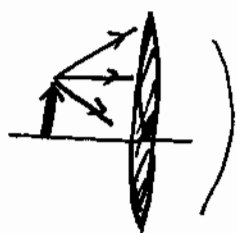
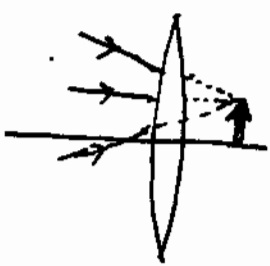
$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

magnification:

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

Sign conventions:

- $\left\{ \begin{array}{l} d_i > 0 \text{ for real images} \\ (+) \end{array} \right.$ (opposite side of the lens from the object)
- $\left\{ \begin{array}{l} d_i < 0 \text{ for virtual images} \\ (-) \end{array} \right.$ (same side as the object)

- $\left\{ \begin{array}{l} d_o > 0 \text{ for real objects} \\ (+) \end{array} \right.$ (light diverges from it) 
- $\left\{ \begin{array}{l} d_o < 0 \text{ for virtual objects} \\ (-) \end{array} \right.$ (light converges to it) 

Typically occurs in Multilens systems (ch 27)

- $\left\{ \begin{array}{l} f > 0 \text{ for converging lenses (convex)} \\ f < 0 \text{ for diverging lenses (concave)} \end{array} \right.$

e.g. lens 1.

$$\frac{1}{d_{o1}} + \frac{1}{d_{i1}} = \frac{1}{f_1}$$

$$\frac{1}{d_{i1}} = \frac{1}{f_1} - \frac{1}{d_{o1}} = \frac{d_{o1} - f_1}{f_1 d_{o1}}$$

$$d_{i1} = \frac{f_1 d_{o1}}{d_{o1} - f_1} = \frac{(-7.0)(24)}{(24 + 7)} = \frac{-168}{31} = -5.4 \text{ cm}$$

Lens 2:

$$d_{o2} = 5.4 + 35 = 40.4 \text{ cm}$$

$$\frac{1}{d_{i2}} = \frac{1}{f_2} - \frac{1}{d_{o2}}$$

$$d_{i2} = \frac{f_2 d_{o2}}{d_{o2} - f_2} = \frac{(14)(40.4)}{(40.4 - 14)} = 21.4 \text{ cm}$$

Magnification:

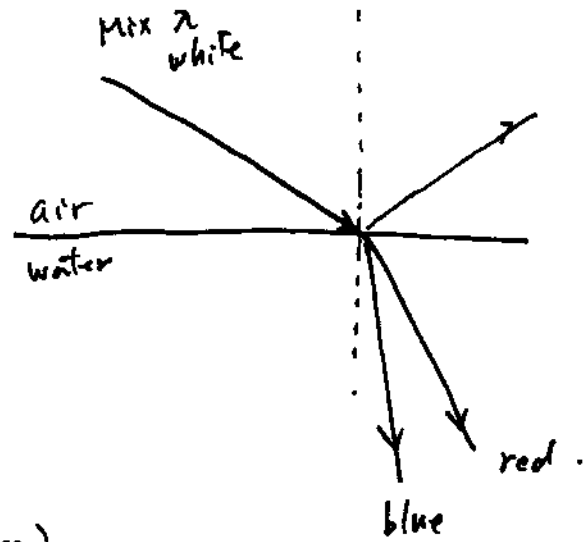
$$m_1 = -\frac{d_{i1}}{d_{o1}} = -\frac{(-5.4)}{24} = 0.225$$

$$m_2 = -\frac{d_{i2}}{d_{o2}} = -\frac{21.4}{40.4} = -0.530$$

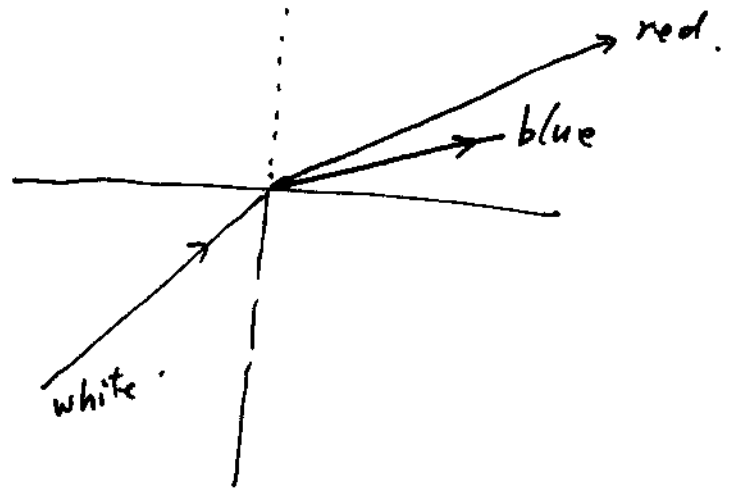
$$\text{Total: } m = m_1 m_2 = -0.12$$

• Dispersion

— refractive index depends on frequency. (colour).



The higher the freq.
the greater the n . (bent more).



That's why we see the Rain bow.

demo : prism.
lens.