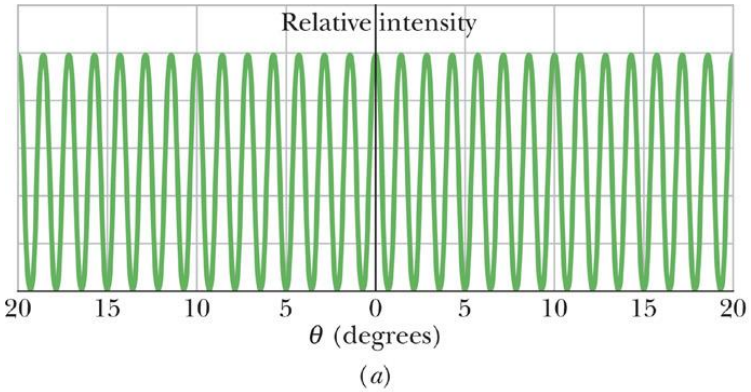
Copyright statement

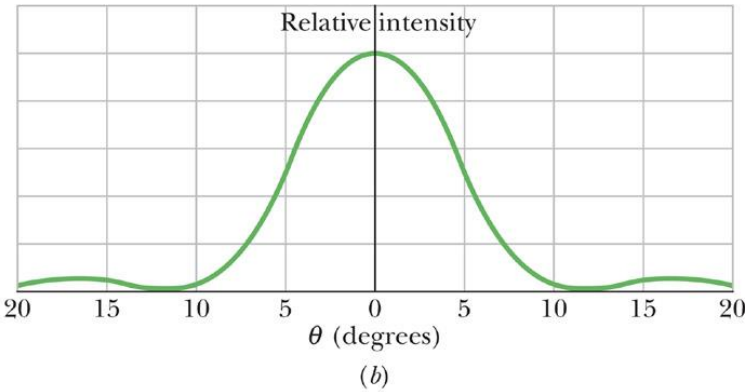
- The images and the pictures in this lecture are provided by the CDs accompanied by the books

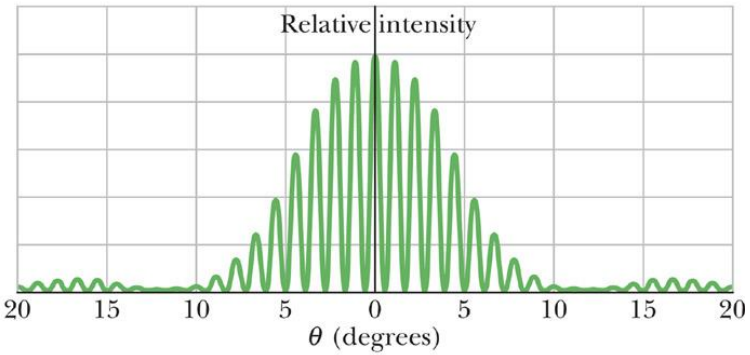
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8th and 9th Ed.

- The rest is made by me.

Double slit diffraction







$$I = I_m \cos^2 \beta \left(\frac{\sin \alpha}{\alpha} \right)^2$$

$$\beta = \frac{\pi d}{\lambda} \sin \theta$$

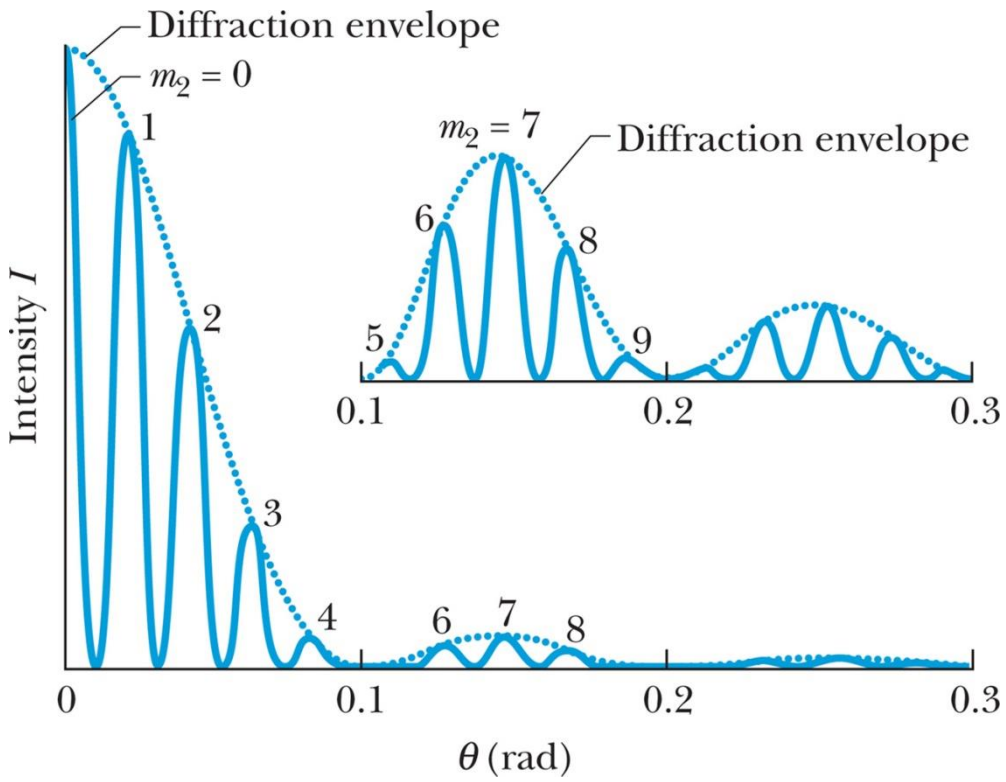
$$\alpha = \frac{\pi a}{\lambda} \sin \theta$$

Double slit (a)

Single slit (b)

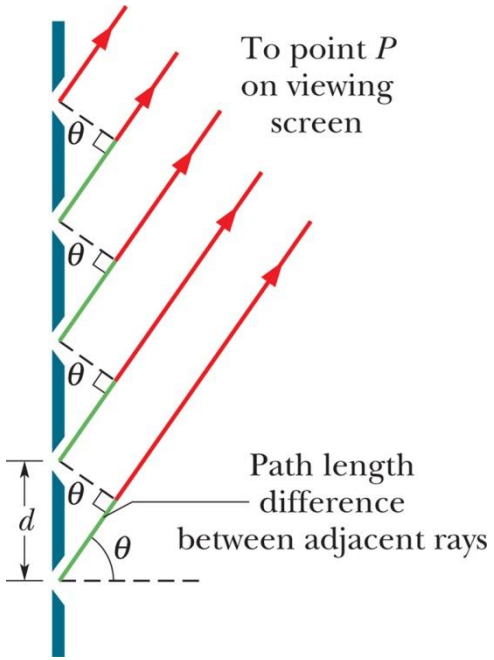
Example

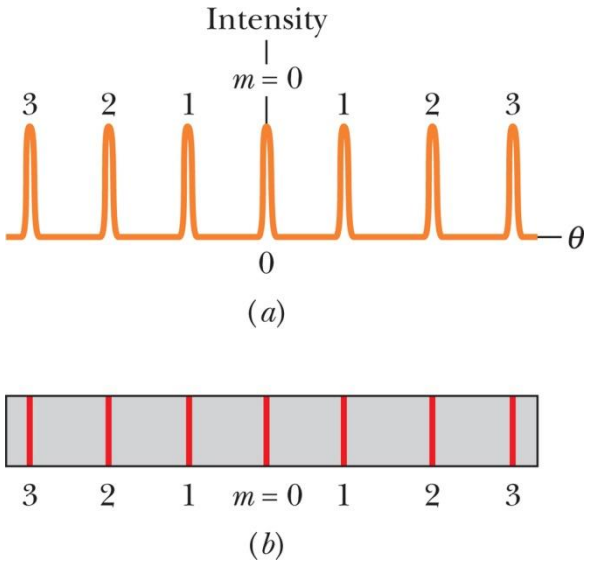
$\lambda = 405\ \text{nm},\ d = 19.44\ \mu\text{m},\ a = 4.050\ \mu\text{m}$

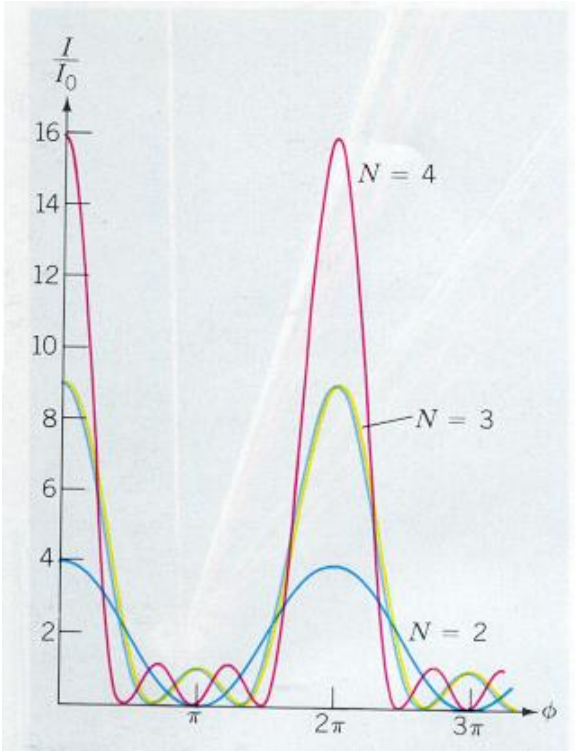


(a) 중앙극대의 밝은 간섭무늬 개수
(b) 이차극대의 밝은 간섭무늬 개수

Gratings





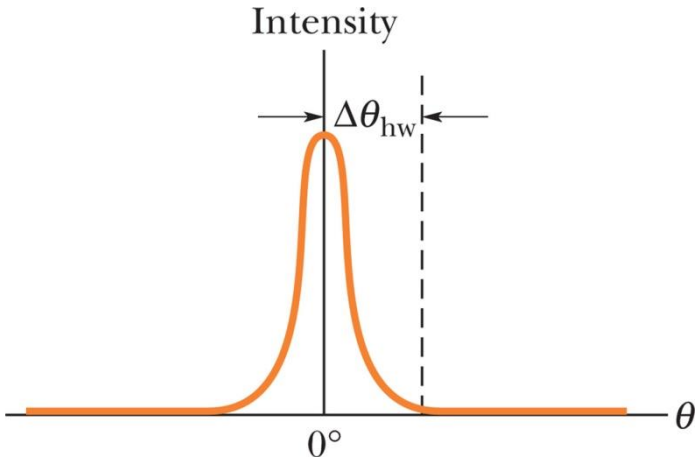


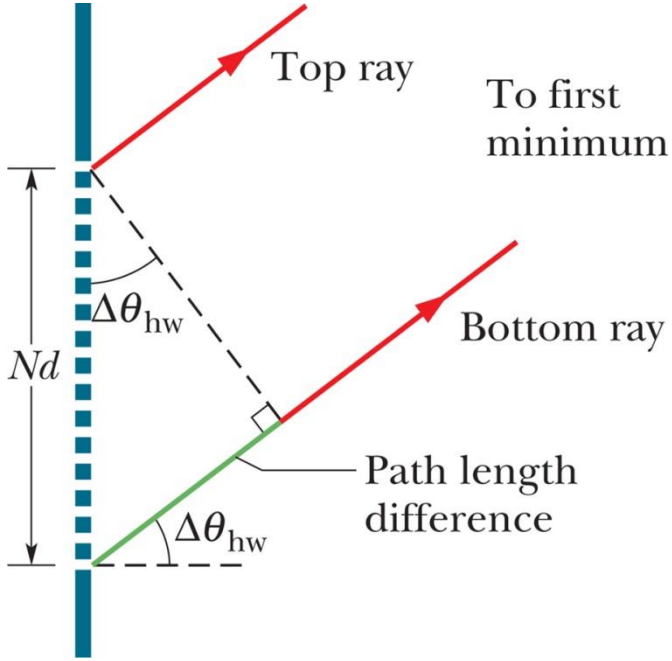
$$d \sin\theta = m\lambda \ (m = 0, 1, 2, 3, \cdots)$$

$N = 2$

$N = 5$

Width of diffraction pattern





$$Nd \sin \Delta\theta_{hw} = \lambda$$

$$\Delta\theta_{hw} = \frac{\lambda}{Nd}$$

half-width angle at the center

$$\Delta\theta_{hw} = \frac{\lambda}{Nd\cos\theta}$$

Half-width angle at arbitrary position

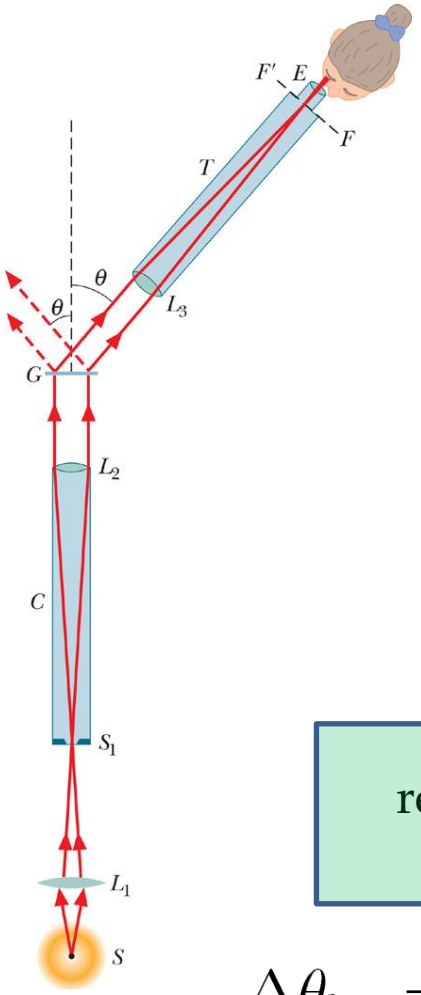
$$Nd \sin\theta = m\lambda$$

$$Nd\cos\theta\Delta\theta = \Delta m\lambda$$

$$\Delta m = 1$$

$$\Delta\theta = \frac{\lambda}{Nd\cos\theta}$$

Dispersion vs. resolving power



dispersion $$D = \frac{\Delta\theta}{\Delta\lambda}$$

$\Delta\theta$: 파장이 $\Delta\lambda$만큼 다른 두 빛의 diffraction 선 사이의 분리각

$$d\sin\theta = m\lambda \quad d\cos\theta\Delta\theta = m\Delta\lambda$$

$$D = \frac{\Delta\theta}{\Delta\lambda} = \frac{m}{d\cos\theta}$$

resolution $$R = \frac{\lambda_{\text{avg}}}{\Delta\lambda}$$

λ_{avg} 겨우 분해할 수 있는 빛의 파장의 평균값

$$\Delta\theta_{\text{hw}} = \frac{\lambda}{Nd\cos\theta} = \frac{m\Delta\lambda}{d\cos\theta}$$

$$R = \frac{\lambda}{\Delta\lambda} = Nm$$

dispersion

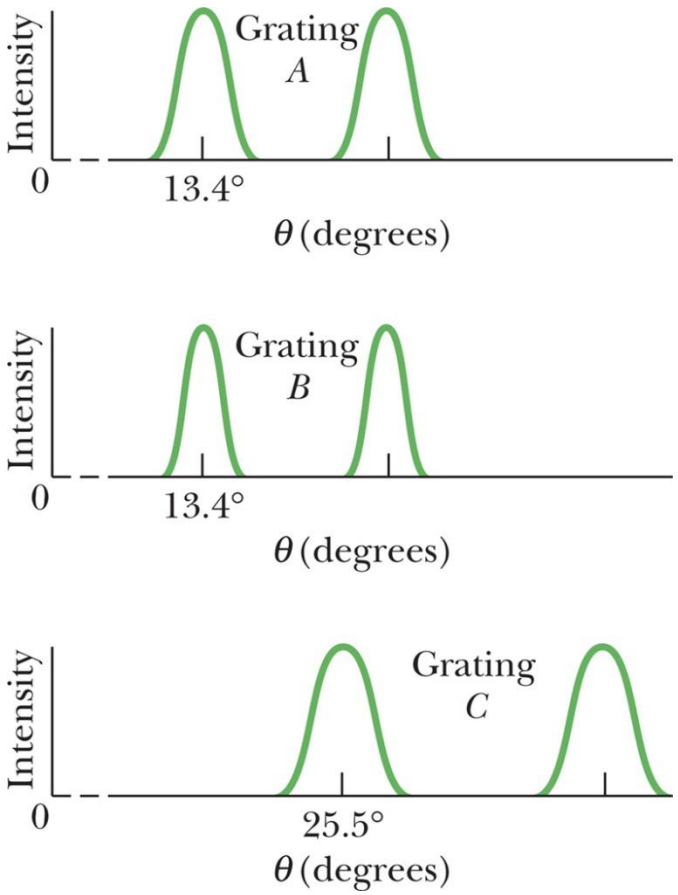
파장이 비슷한 빛을 분리하려면 이들의 회절무늬가 서로 떨어져 있어야 한다.

$$D \equiv \frac{\Delta\theta}{\Delta\lambda} = \frac{m}{d\cos\theta}$$

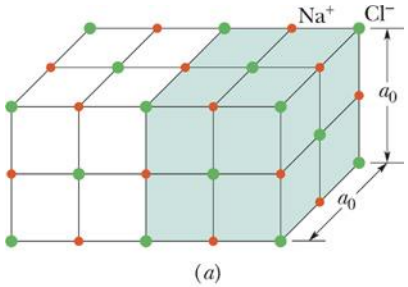
resolving power

파장이 비슷한 빛들을 구별하려면, 선들이 가능한한 가늘어야 한다.

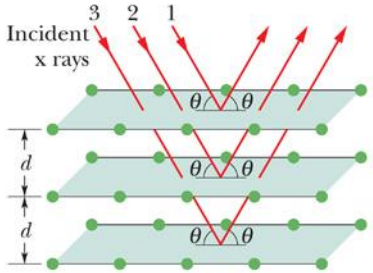
$$R \equiv \frac{\lambda_{av}}{\Delta\lambda} = Nm$$



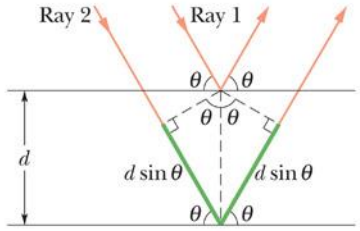
X-ray diffraction: Bragg's law



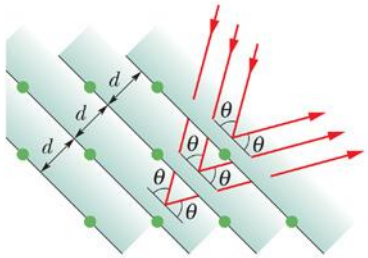
(a)



(b)

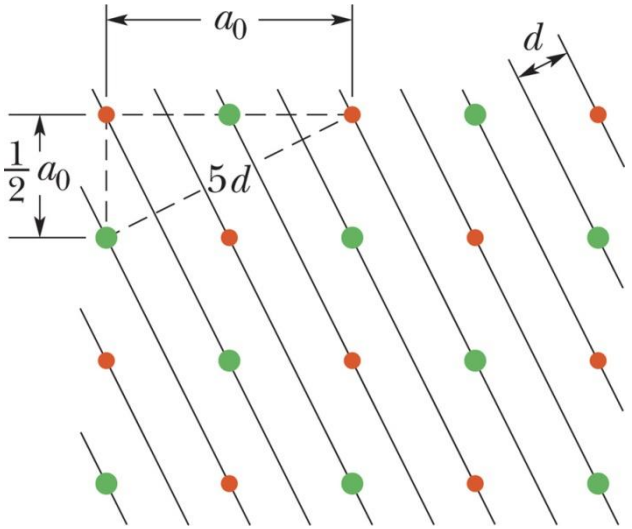


(c)

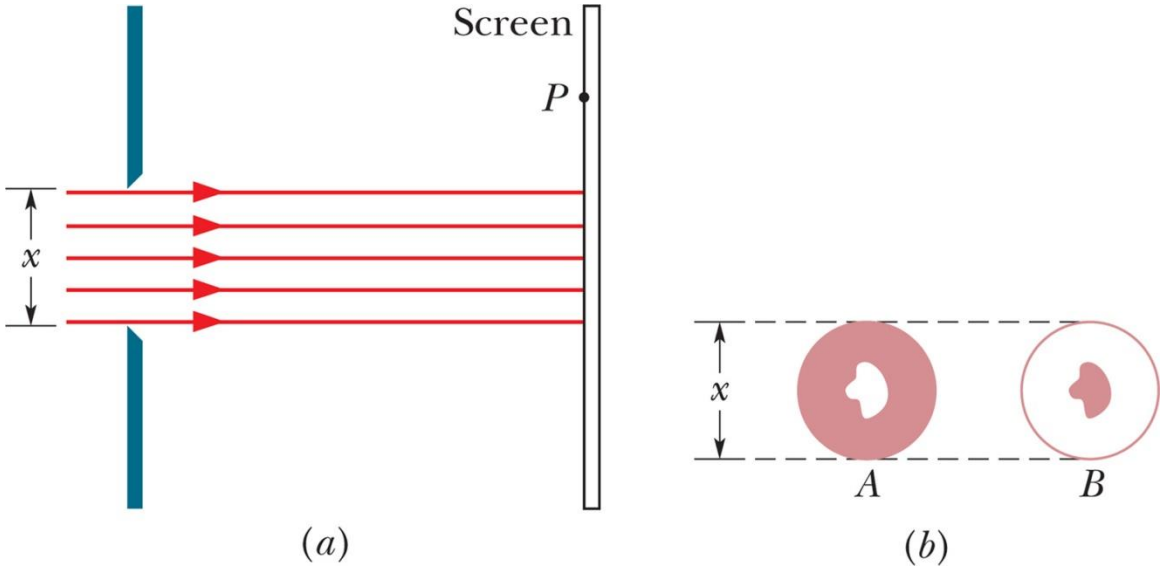


(d)

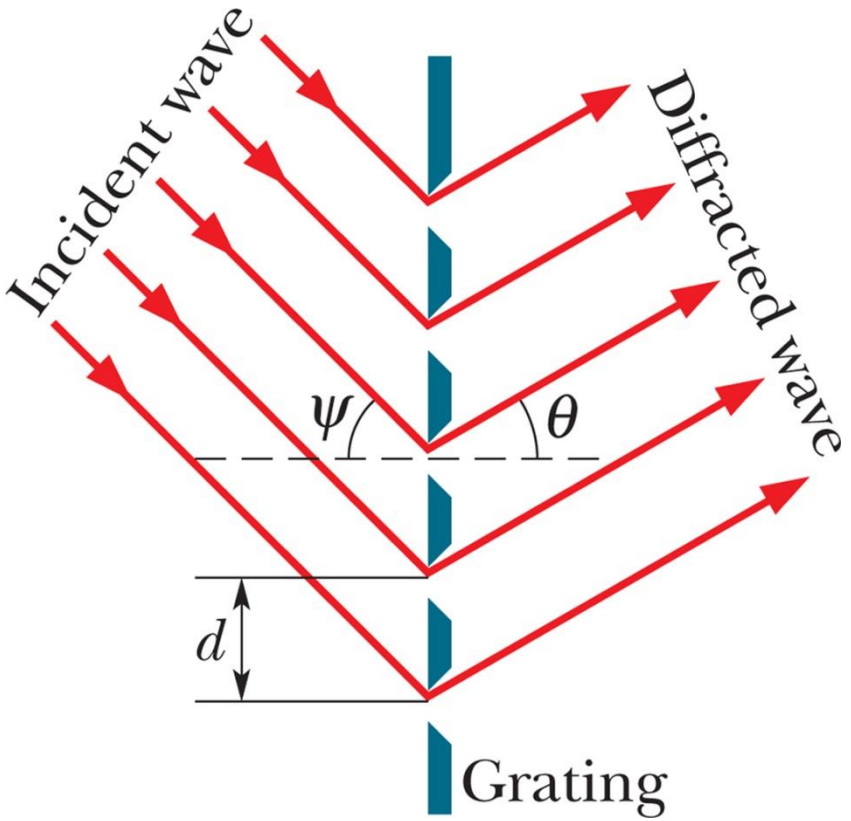
Maximum condition $2d \sin\theta = m\lambda \ (m = 1, 2, 3, \cdots)$



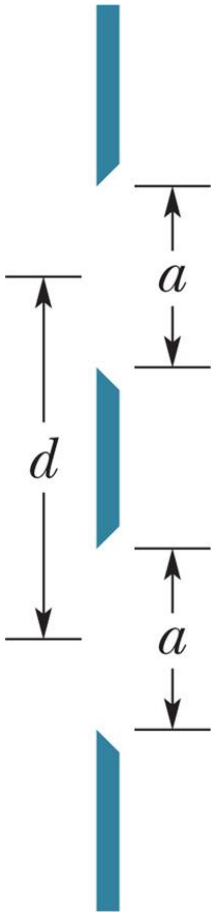
Problem: Babinet의 원리



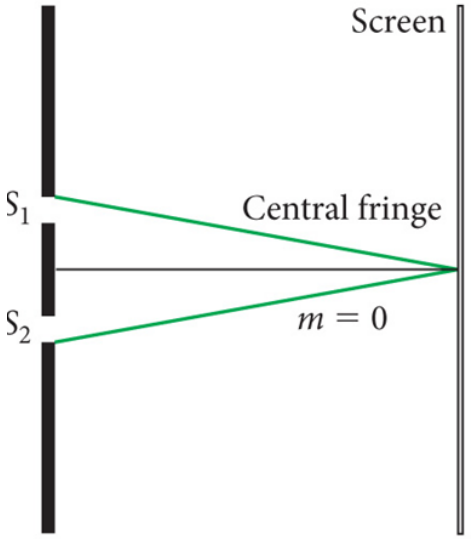
Problem



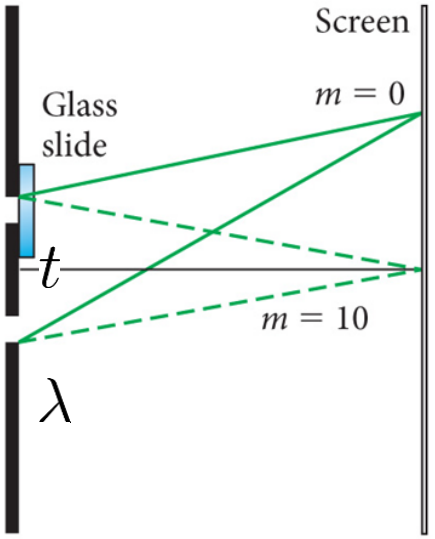
Problem



Problem



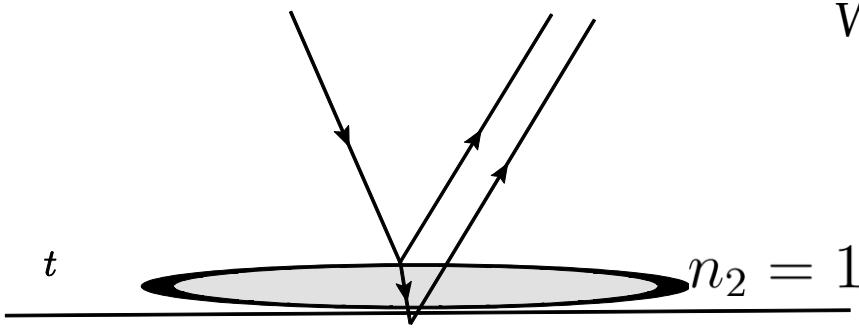
(a) Without the glass slide



(b) With glass slide

$n = ?$

Problem

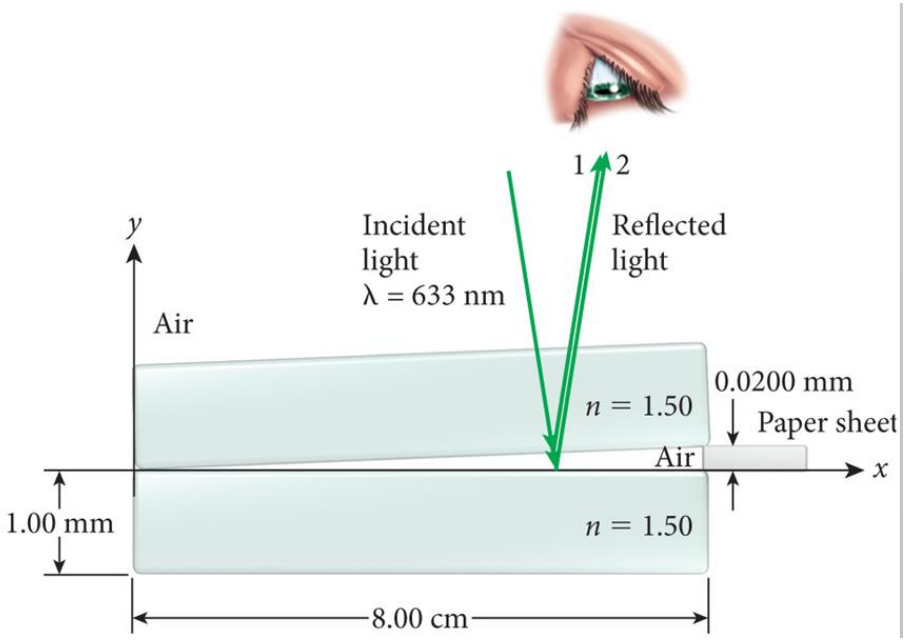


White light $400 \text{ nm} < \lambda < 750 \text{ nm}$

$t = 100.0 \text{ nm}$

$n_1 = 1.33$

Problem



Number of maxima?

Problem

$a, d, \lambda?$