Lecture 34

Interference

constructive interference

$R = d \sin\theta = n\lambda$; $n < \frac{d}{\lambda}$

$\sin\theta = n\lambda / d$

destructive interference

$d \sin\theta = (n + \frac{1}{2})\lambda$

$n + \frac{1}{2} < \frac{d}{\lambda}$

λ = wavelength

$\lambda = \frac{c}{f}$

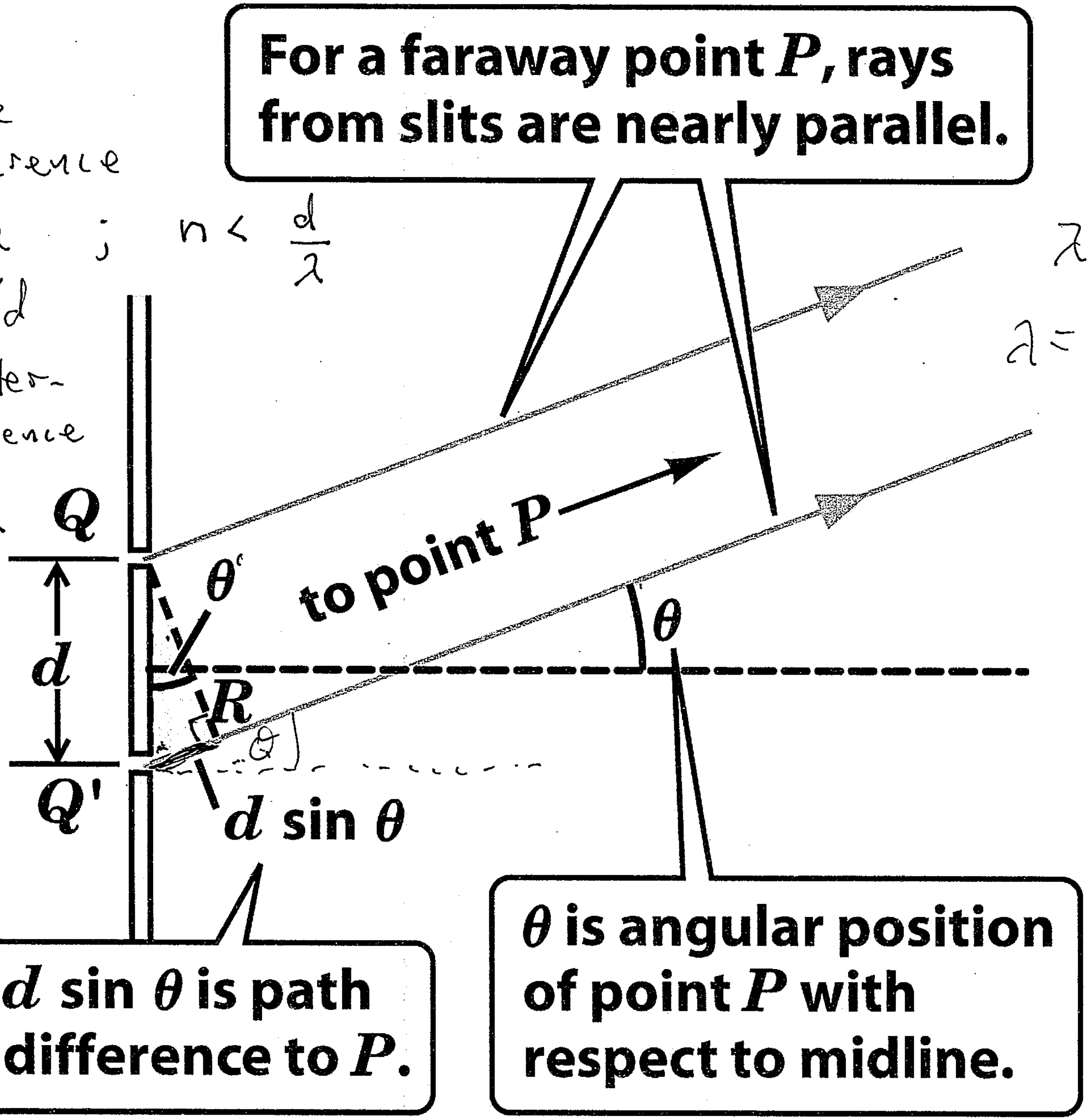


Figure 35-15 Physics for Engineers and Scientists 3/e

Projecting Constructive & Destructive Interference of a screen.

constructive: $n\lambda = d\sin\theta_n$; $\tan\theta_n = y_n/L$; $n < d/\lambda$

if $\frac{n\lambda}{d} \ll 1$; $n\lambda \simeq d\theta_n$; $\theta_n = y_n/L$ $\therefore$ $n\lambda = d\,y_n/L$

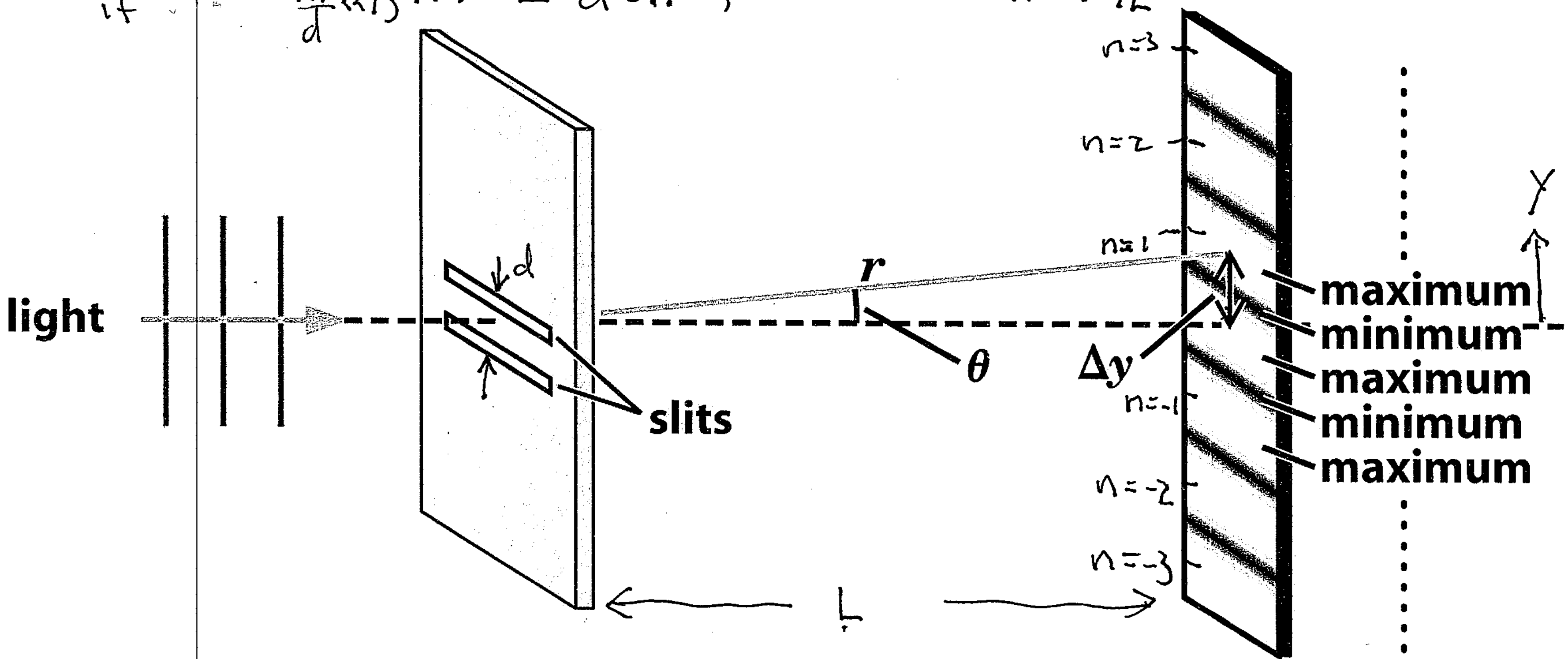


Figure 35-17b Physics for Engineers and Scientists 3/e

destructive: $(n+1/2)\lambda = d\sin\theta_n$; $\tan\theta_n = y_n/L$; $n + 1/2 < \frac{d}{\lambda}$

if $\frac{n\lambda}{d} \ll 1$; $(n+1/2)\lambda \simeq d\theta_n$; $\theta_n = \frac{y_n}{L}$ $\therefore$ $(n+\frac{1}{2})\lambda \simeq \frac{d\,y_n}{L}$

(TB)

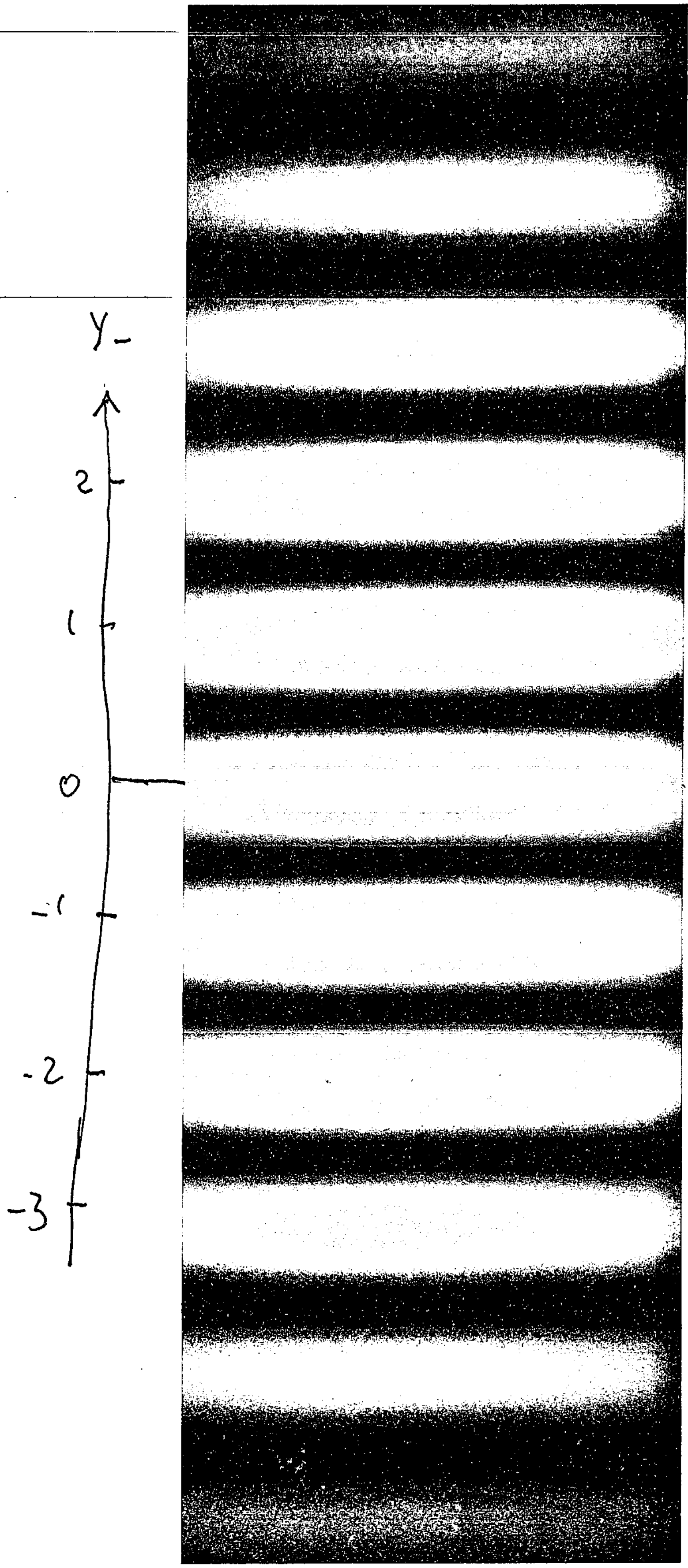
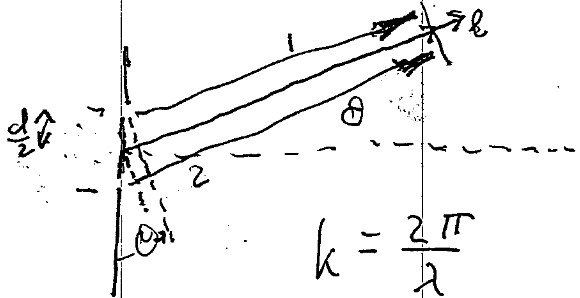


Figure 35-17a Physics for Engineers and Scientists 3/e
Courtesy of Chris C. Jones

Brightness of Screen from 2-slit experiment



$l_1 = l - \frac{d}{2}\sin\theta$

$l_2 = l + \frac{d}{2}\sin\theta$

$k = \frac{2\pi}{\lambda}$

$E = E_0 \cos(\omega t - kl - \frac{kd}{2}\sin\theta) + E_0 \cos(\omega t - kl + \frac{kd}{2}\sin\theta)$

$= 2 E_0 \cos(\omega t - kl) \cos(\frac{kd}{2}\sin\theta)$

$I(t) \propto 4 E_0^2 \cos^2(\omega t - kl) \cos^2[\frac{kd}{2}\sin\theta]$

$= 2 E_0^2 \cos^2(\frac{kd}{2}\sin\theta)$

max $= \frac{kd}{2}\sin\theta = n\pi$ or $d\sin\theta/\lambda = n$ | min $\frac{kd}{2}\sin\theta = (n+\frac{1}{2})\pi$ or $d\sin\theta/\lambda = n + \frac{1}{2}$

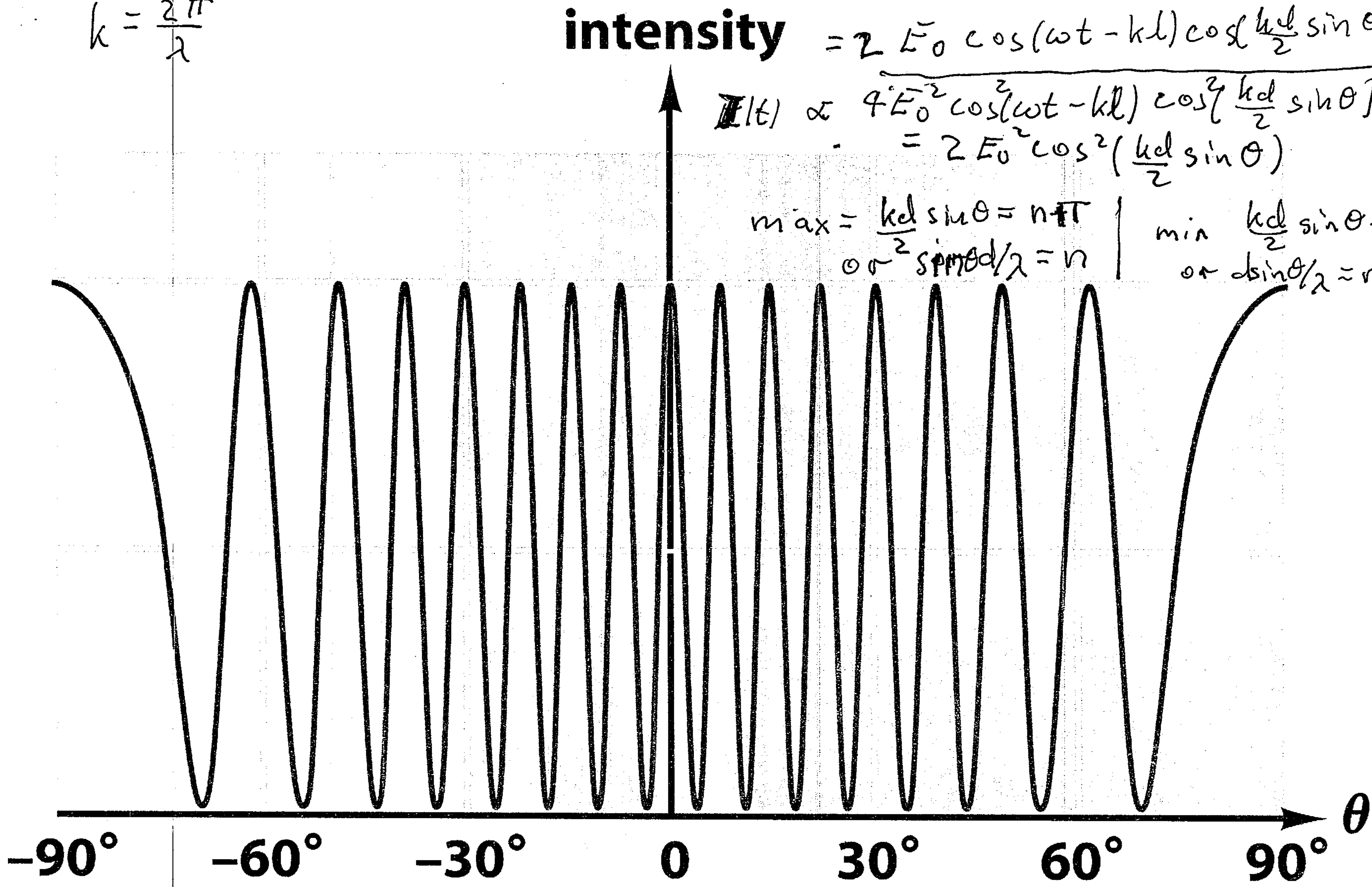


Figure 35-19 Physics for Engineers and Scientists 3/e

Multiple Slits

3 - slits

4 slits

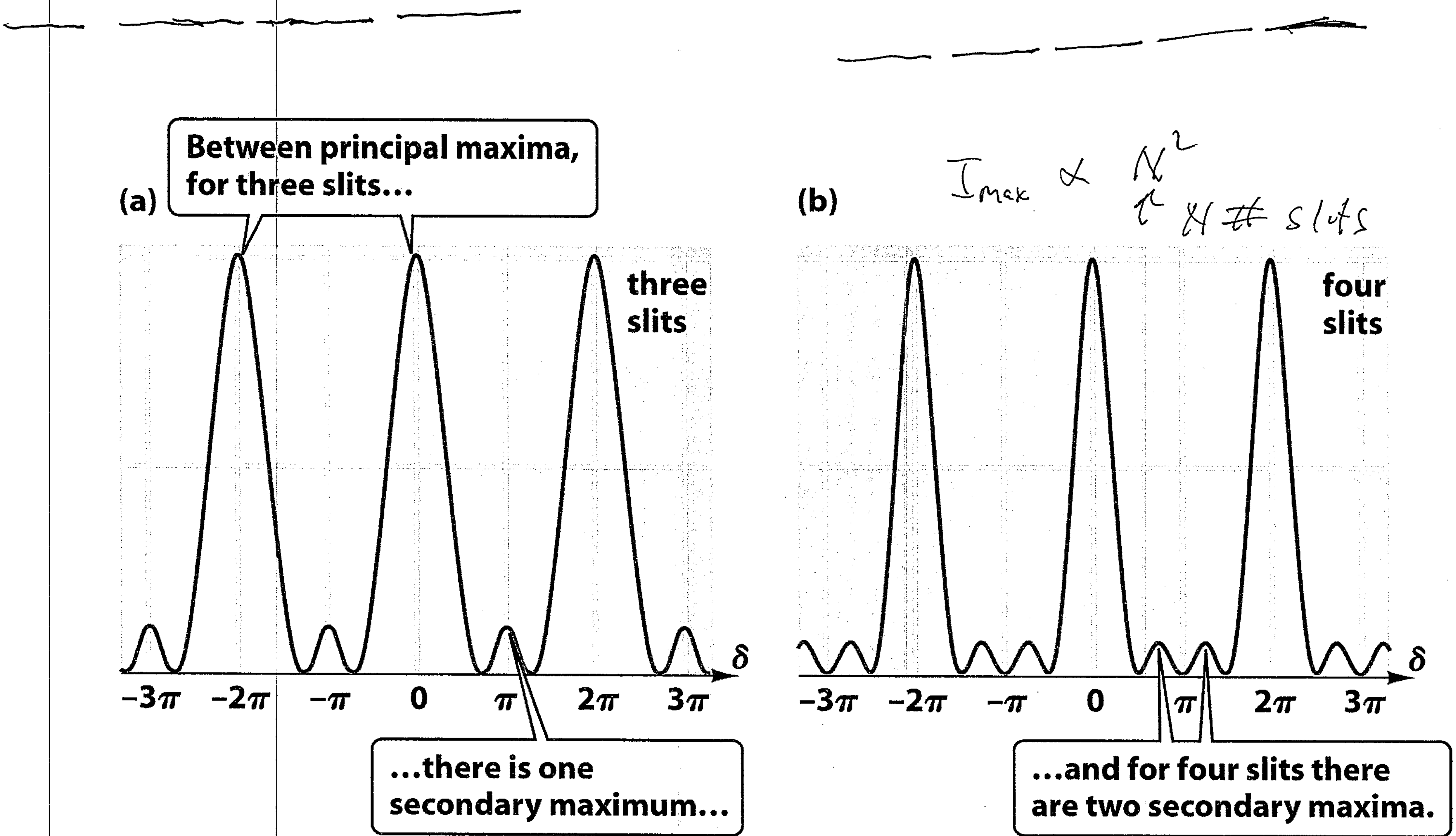


Figure 35-27 Physics for Engineers and Scientists 3/e

Principal Maxima Get Sharper

but position of maxima look the same

$d \sin\theta = n\lambda$

Diffraction Grating Bend long wavelength light more than short wavelength (opposite of refractive light separation)

$d \sin\theta = n\lambda$

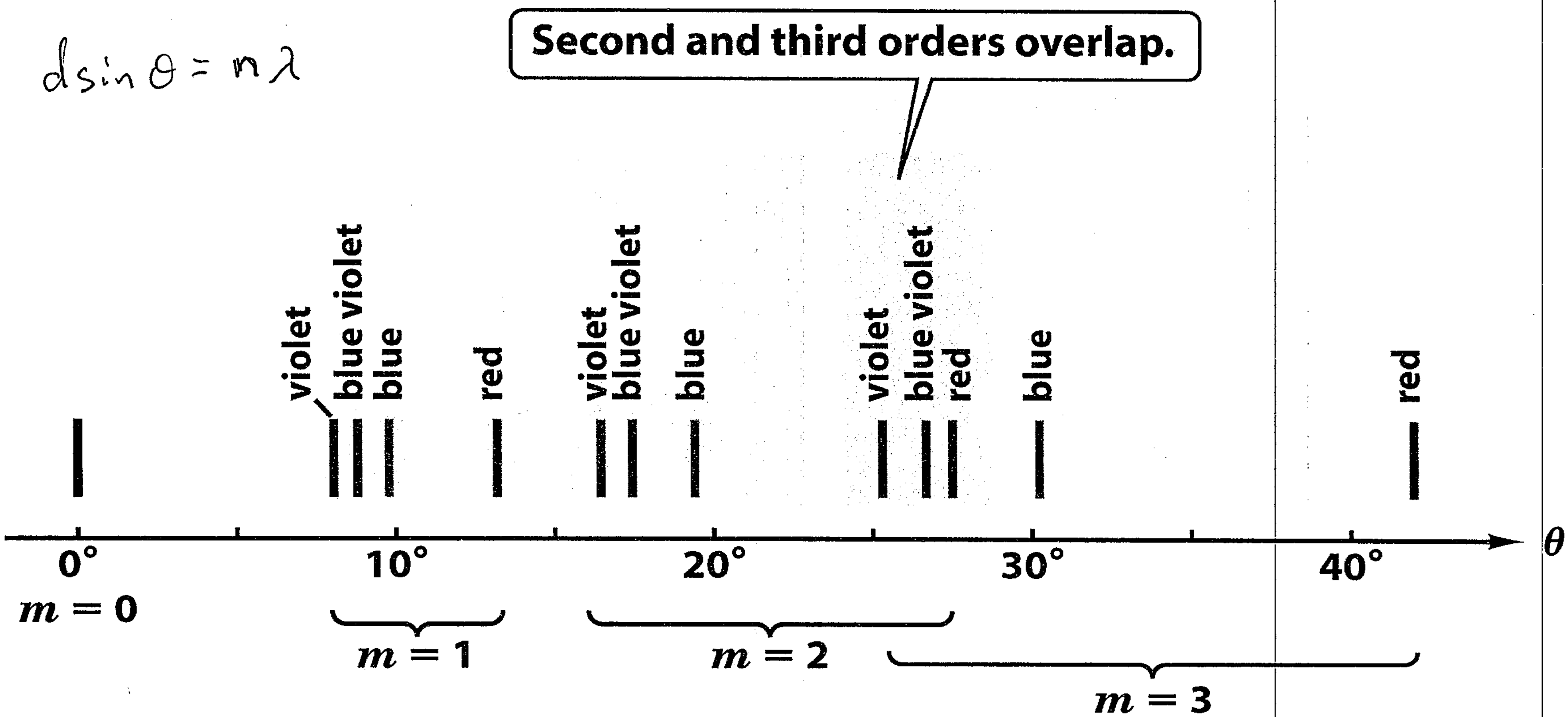


Figure 35-22 Physics for Engineers and Scientists 3/e

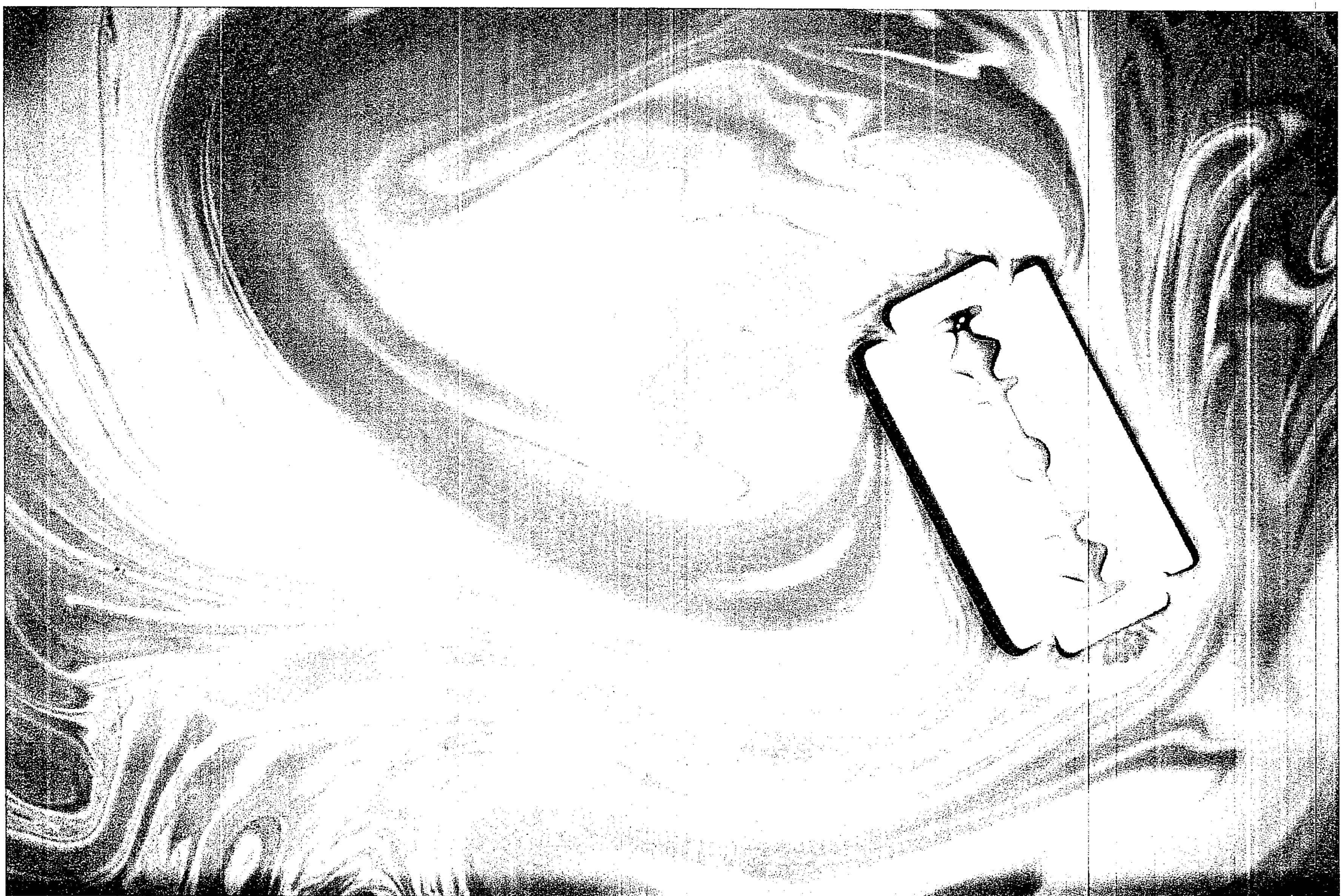


Figure 35-1 Physics for Engineers and Scientists 3/e
Peter Aprahamian/Photo Researchers, Inc.

7

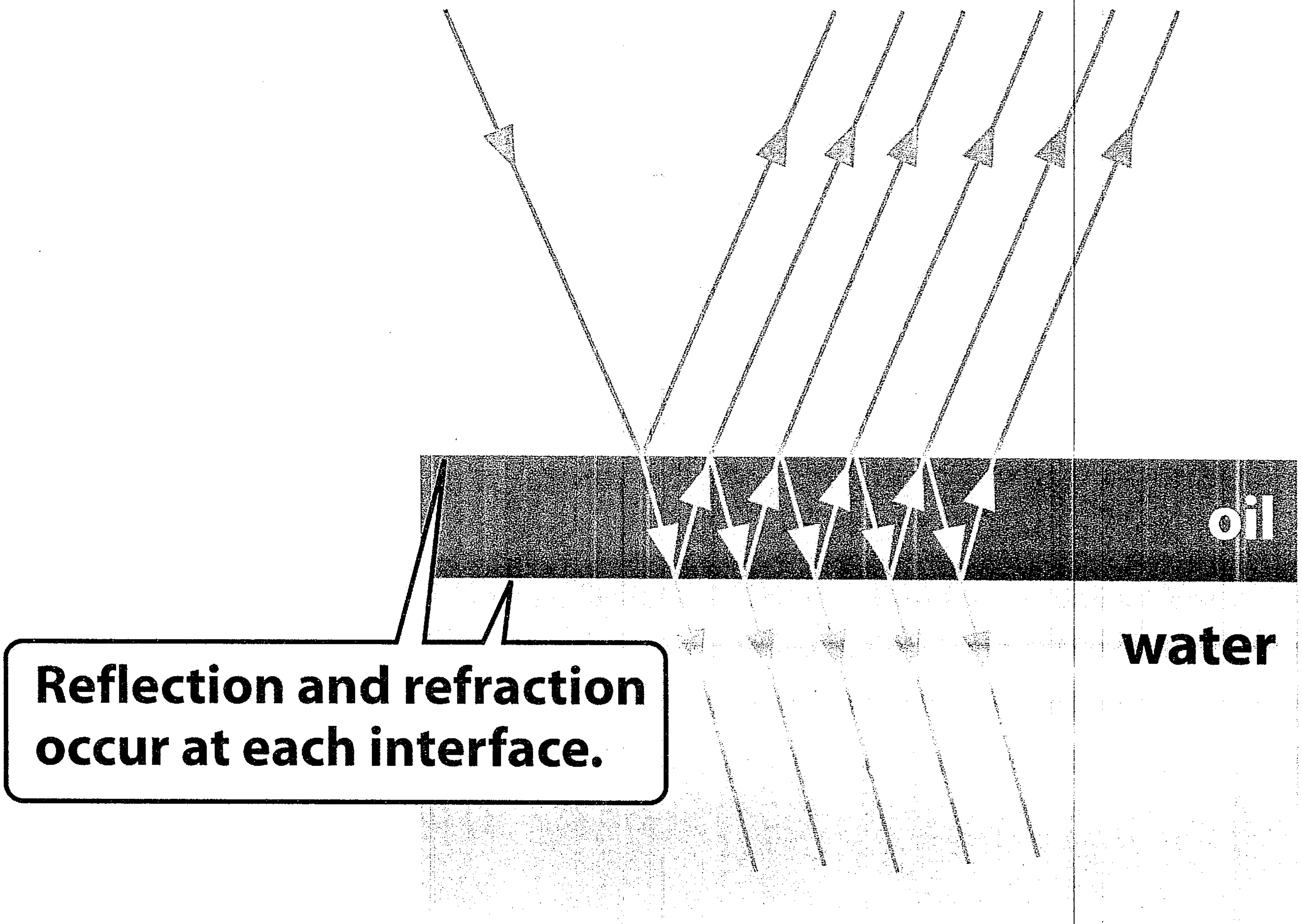


Figure 35-2 Physics for Engineers and Scientists 3/e

(8)

$$E = E_0 \cos(\omega t - kd) + E_0 \cos(\omega t - kd + \phi)$$

$$\phi = \frac{2\pi}{\lambda_{oil}}(2d) = \frac{2\pi}{\lambda_{oil}}(2d) = \frac{4\pi d n_{oil}}{\lambda}$$

$$\lambda_{oil} = \frac{v_{oil}}{f}, \quad \lambda_{air} = \frac{c}{f}$$

$$\lambda_{oil} = \frac{v_{oil}}{c}\lambda_{air} = \frac{\lambda}{c/v_{oil}} = \frac{\lambda}{n_{oil}}$$

$$\phi = \frac{4\pi d n_{air}}{\lambda} = \pi$$

$$\frac{\lambda}{d n_{air}} = \frac{1}{4}$$

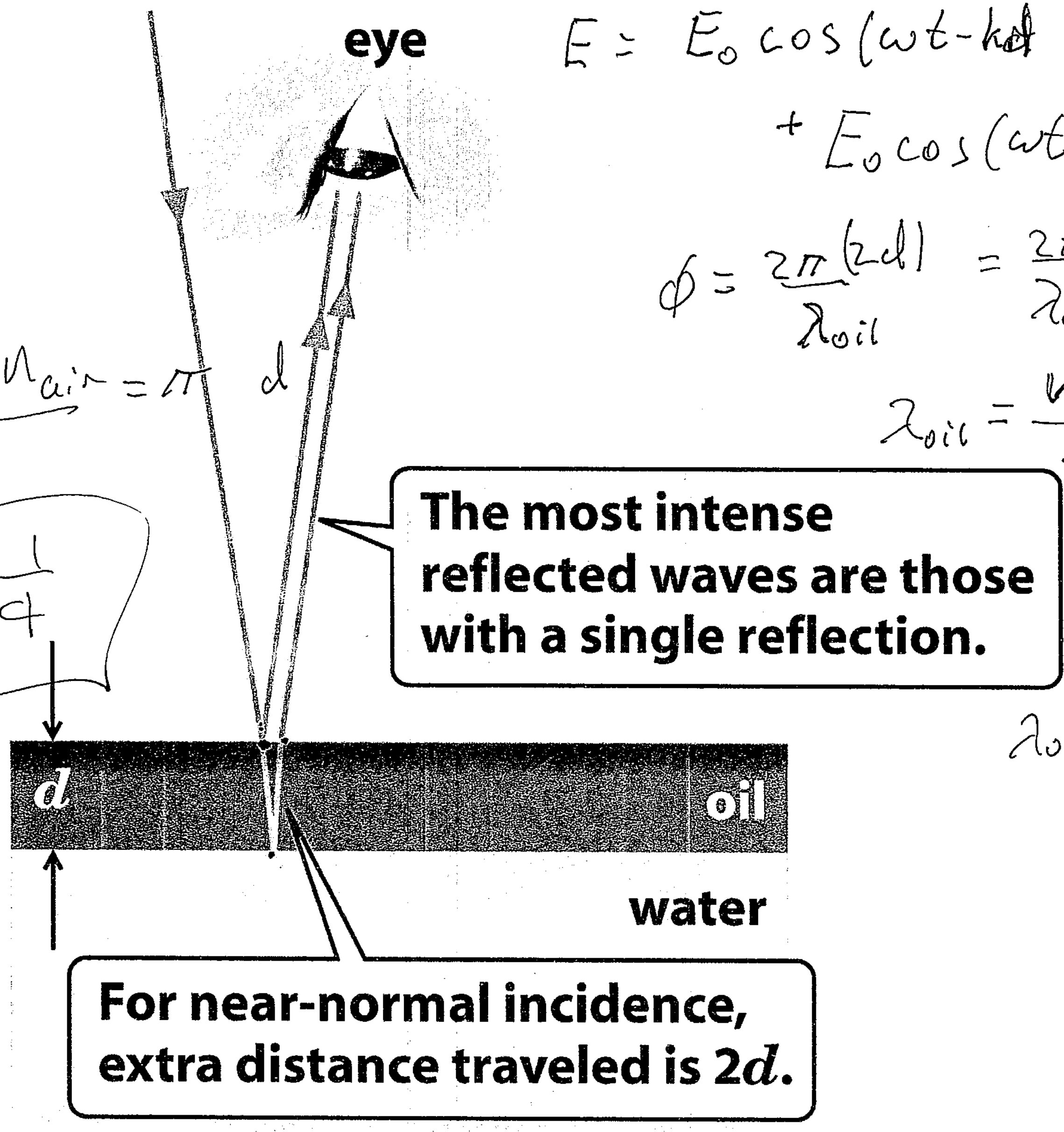


Figure 35-3 Physics for Engineers and Scientists 3/e