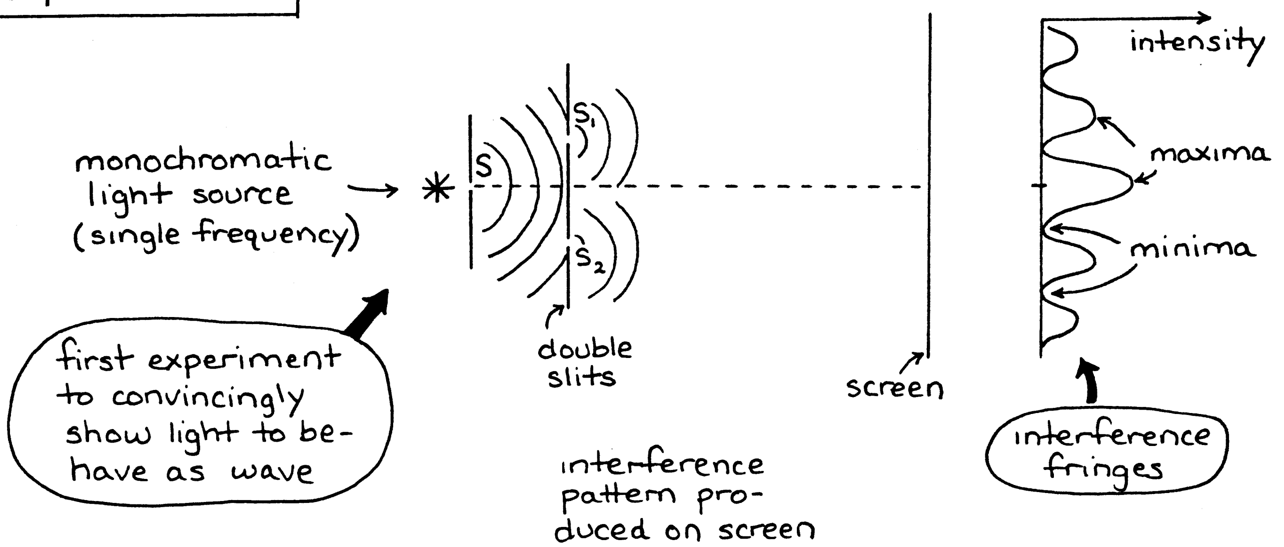
YOUNG'S DOUBLE-SLIT EXP.

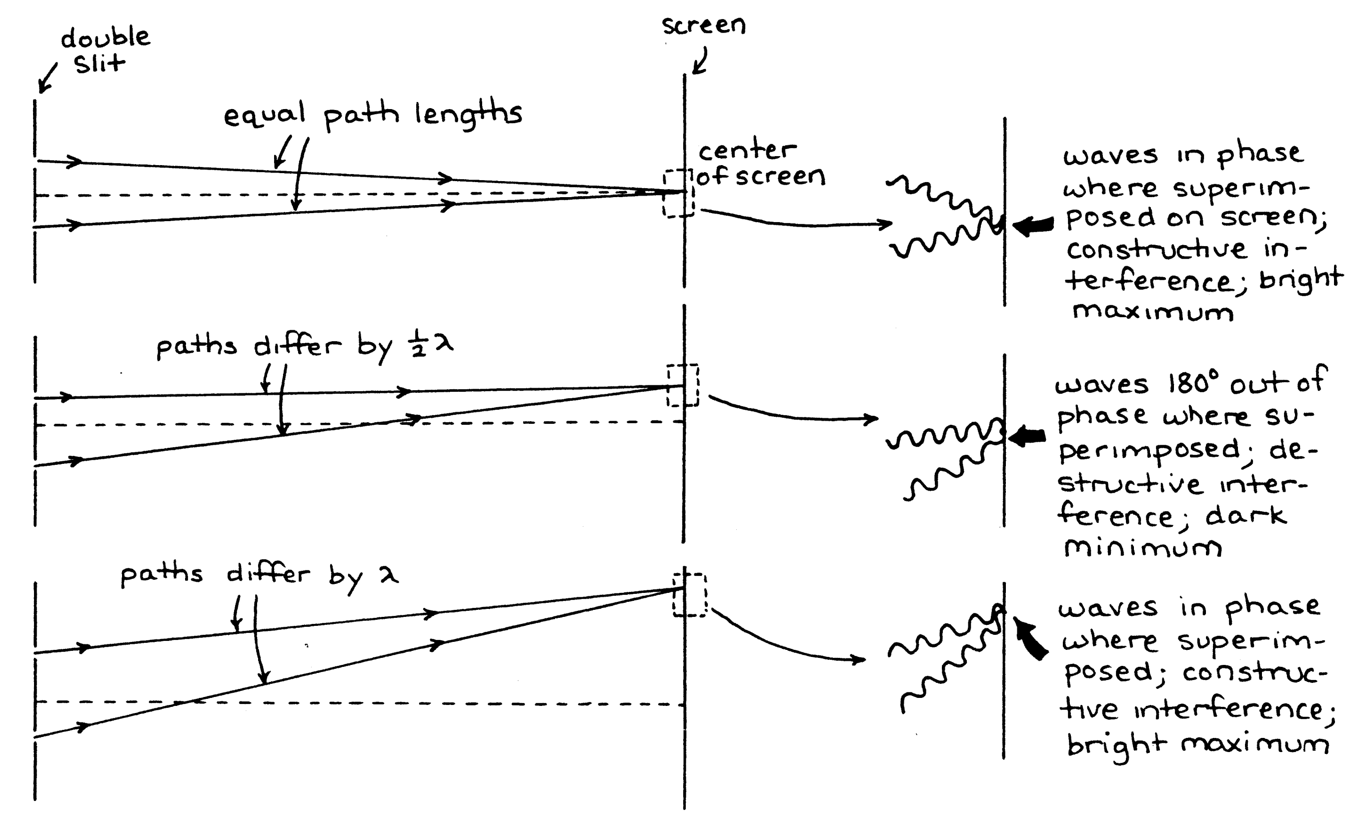
<u>physical optics</u> - the behavior of EM radiation (esp. light) understood in terms of wave motion and wave characteristics

Young's Double-Slit Experiment

carried out by Thomas Young (English) in 1801

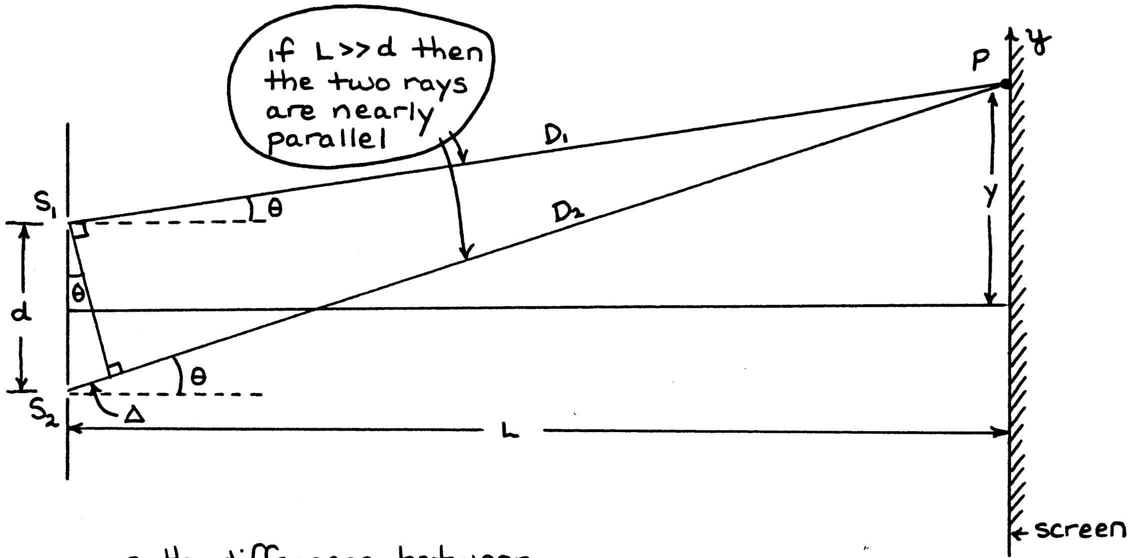


<u>Young's Experiment Geometry</u>



DOUBLE-SLIT INTERFERENCE

general geometry



path difference between rays 1 and 2 given by: $\Delta = D_2 - D_1$

note: $\frac{\Delta}{d} = \sin\theta \Rightarrow \Delta = d\sin\theta$

* if $\Delta = 0$ or an integer number of wavelengths λ, then we have constructive interference and a bright maximum on the screen at point P

conditions for max

$\Delta = n\lambda$ for $n = 0, 1, 2, \ldots$

$\boxed{d\sin\theta = n\lambda \text{ for } n \text{ integer}}$

if θ is small, $\sin\theta \approx \tan\theta = \frac{y}{L}$

then $\boxed{\frac{dy}{L} = n\lambda \text{ for } n \text{ integer}}$

* if $\Delta = \frac{1}{2}\lambda, \frac{3}{2}\lambda, \frac{5}{2}\lambda$ or an odd number of $\frac{1}{2}\lambda$, then we have destructive interference and a dark minimum on the screen at point P

conditions for min.

$\Delta = (n+\frac{1}{2})\lambda$ for $n = 0, 1, 2, \ldots$

$\boxed{d\sin\theta = (n+\frac{1}{2})\lambda \text{ for } n \text{ int.}}$

if θ is small, $\sin\theta \approx \tan\theta = \frac{y}{L}$

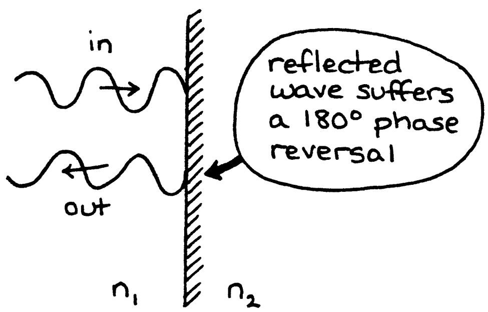
$\boxed{\text{then } \frac{dy}{L} = (n+\frac{1}{2})\lambda \text{ for } n \text{ int}}$

eg What is the wavelength of light if a Young's experiment is performed in which the slit spacing is 0.05 mm, the screen is 2.0 meters away from the slits, and the second order bright fringe is 4.8 cm from the central maximum on the screen?

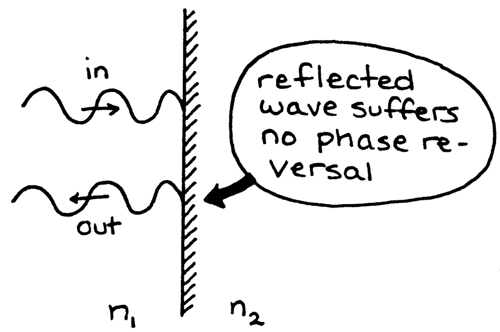
WAVE REFLECTIONS

wave reflections

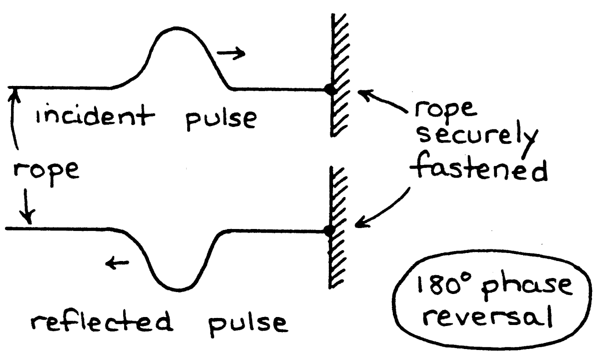
case 1 $n_2 > n_1$

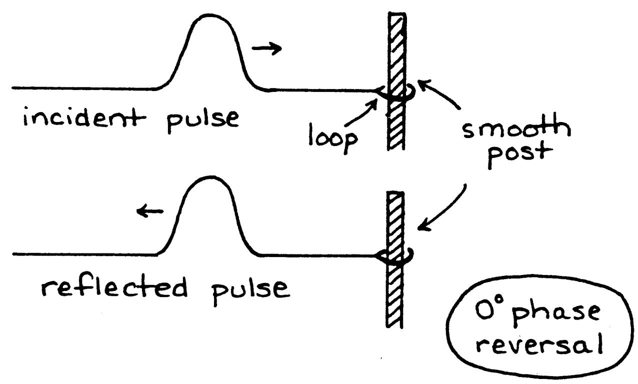


case 2 $n_1 > n_2$

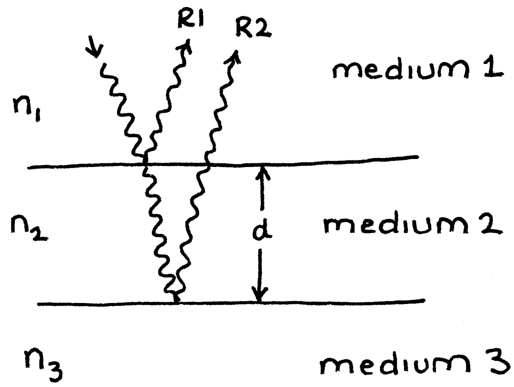


mechanical analog





THIN FILM INTERFERENCE



λ_0 = wavelength of light in vacuum

* If rays R1 and R2 interfere constructively, maximum reflected intensity (and minimum transmitted intensity) is obtained

* If rays R1 and R2 interfere destructively, maximum transmitted intensity (and minimum reflected intensity) is obtained

conditions for:

maximum reflection

$2d = m\frac{\lambda_0}{n_2}$ (m: integer) and $n_1 < n_2 < n_3$ or $n_1 > n_2 > n_3$

or

$2d = (m+\frac{1}{2})\frac{\lambda_0}{n_2}$ and $n_1 < n_2 > n_3$ or $n_1 > n_2 < n_3$

maximum transmission

$2d = m\frac{\lambda_0}{n_2}$ and $n_1 < n_2 > n_3$ or $n_1 > n_2 < n_3$

or

$2d = (m+\frac{1}{2})\frac{\lambda_0}{n_2}$ and $n_1 < n_2 < n_3$ or $n_1 > n_2 > n_3$

summarize

* if $n_1 < n_2 < n_3$ or $n_1 > n_2 > n_3$ say "n's in order"
* if $n_1 < n_2 > n_3$ or $n_1 > n_2 < n_3$ say "n's out of order"
* let o = odd integer
  let e = even integer

	max. ref. min. trans.	max. trans. min. ref.
n's in order	m = e	m = o
n's out of order	m = o	m = e

* always use $4dn_2 = m\lambda_0$