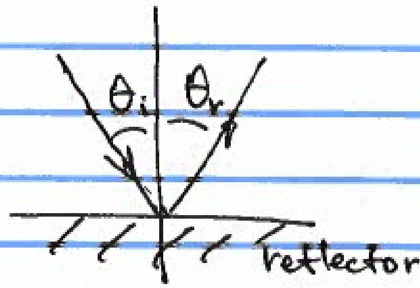
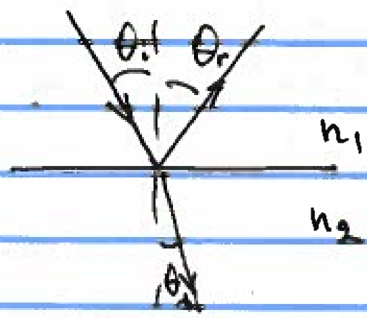
Ray optics

light beams travel is straight lines, unless they hit a boundary



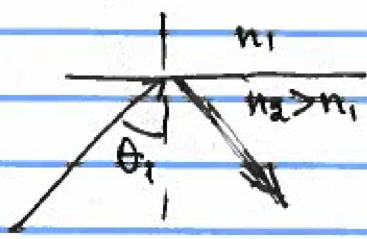
$\theta_i = \theta_r$



$\theta_i = \theta_r$

Snell.s law

$n_1 \sin\theta_i = n_2 \sin\theta_t$



Total internal reflection

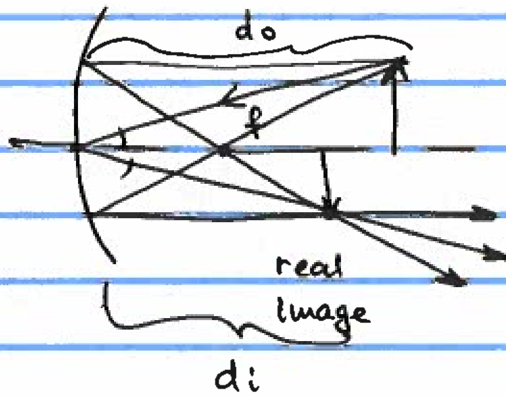
$\theta_i > \theta_{cr}$ – all light is reflected

$n_2 \sin\theta_{cr} = n_1$

Concave / convex mirror

$f = R/2$

focal length ↑ radius of the curvature



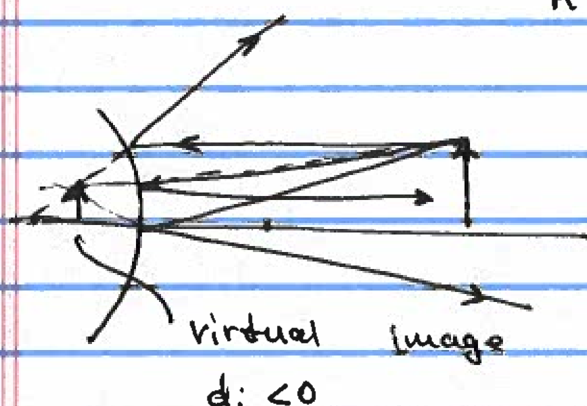
$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

real object — $d_o > 0$

real image — $d_i > 0$

Magnification: $\frac{h_i}{h_o} = -\frac{d_i}{d_o} = M$

$M > 0$ — erect, $M < 0$ — inverted

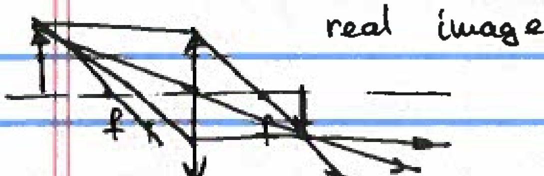


$f < 0$

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

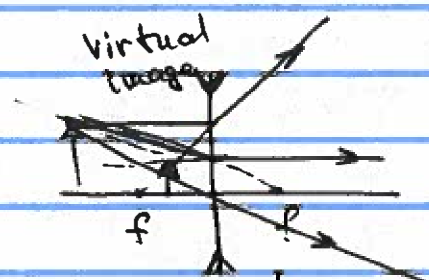
$$\frac{1}{d_o} + \frac{1}{-|d_i|} = \frac{1}{-|f|}$$

Lenses



positive lens

$f > 0$



negative lens

$f < 0$

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

keep track of signs

System of lenses / mirrors

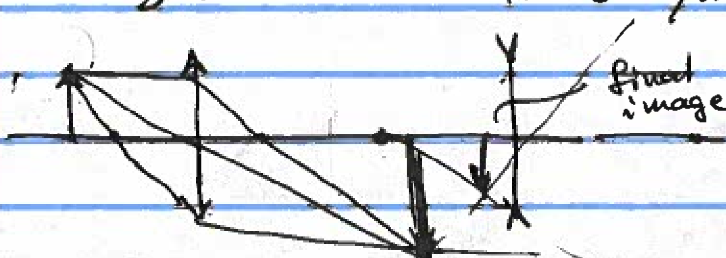
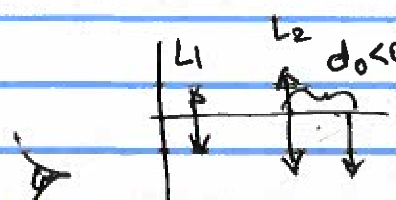


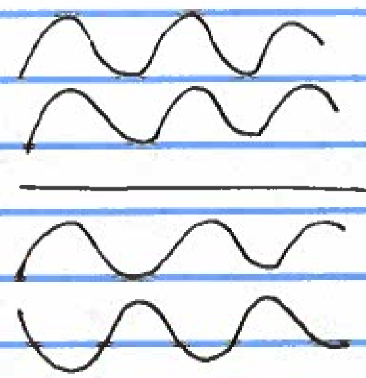
image 1 = object 2



$M = M_1 \cdot M_2$

Wave optics

Interference

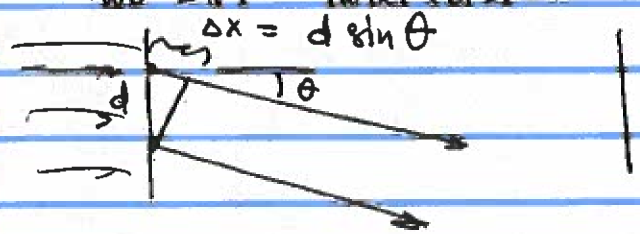


phase diff-ce
$0, 2\pi, 4\pi .. 2\pi \cdot m$
constructive

phase diff-ce
$\pi, 3\pi, 5\pi .. \pi + 2\pi m$
destructive

Two waves that are identical, but one of them travels larger distance

Two-slit interference

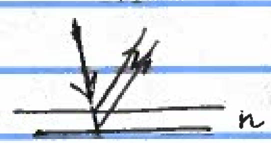


$d \sin\theta = m\lambda$ constructive

$d \sin\theta = \frac{\lambda}{2} + m\lambda$ destructive

phases $k\Delta x = \frac{2\pi}{\lambda} \cdot d \sin\theta = 2\pi m$

Thin-film interference



① top $+\pi$

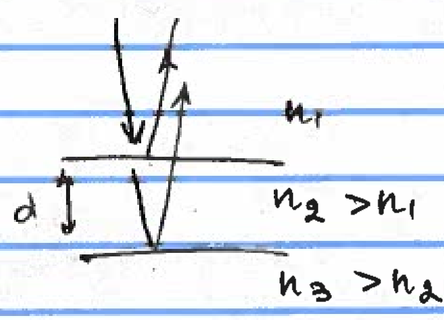
② bottom $2d \cdot \frac{2\pi n}{\lambda}$

phase dieff $(\frac{4d\pi n}{\lambda} - \pi)$

λ_0 – wave length in vacuum

$\lambda = \lambda_0 / n$ — wavelength in material

The beam reflected off ~~the~~ higher n aquires extra π-phase shift



① $+\pi$

② $+\pi + 2d \cdot \frac{2\pi n_2}{\lambda_0}$

~~phase shift~~ $\frac{4\pi d n_2}{\lambda_0}$