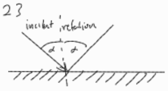
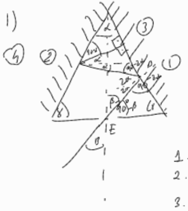
23



1)



$ABCD \Rightarrow \alpha + 2\gamma = 180°$

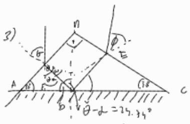
$\Rightarrow \gamma = 90° - \frac{\alpha}{2}$

$CDE\Delta \Rightarrow \cancel{90°} - 2\alpha + \cancel{90°} - \beta + 90° - \frac{\alpha}{2} = \cancel{180}$

$90° - 2.5\alpha = \beta$

1. look for triangles
2. $(n-2) \cdot 180°$ } initial angle
3. reflection / symetric
4. crossing

3)



$1 \cdot \sin\theta = m \sin\alpha$

$\frac{\sqrt{3}}{2} = 1.5 \sin\alpha$

$\frac{\sqrt{3}}{3} = \sin\alpha \Rightarrow \alpha = 35.26°$

$CBE\Delta \Rightarrow \cancel{90°} - 24.75° + 30° + \cancel{90°} - \beta = 180$

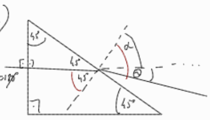
$5.26° = \beta$

$n \sin\beta = 1 \sin\phi$

$1.5 \sin 5.26 = \sin\phi$

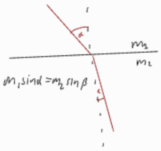
$\phi = 7.9°$

2)



$\theta = 15°$ $\quad \beta = \alpha + \theta = 60°$

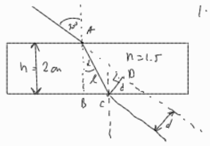
$M = ?$



$m_1 \sin\alpha = m_2 \sin\beta$

$1 \sin(45°) = M_2 \sin(60°)$

$\frac{\sqrt{2}}{2} = M_2 \frac{\sqrt{3}}{2} \quad M_2 = \sqrt{\frac{2}{3}}$



$1 \cdot \sin 30° = n \sin\alpha$

$\frac{1}{2} = 1.5 \sin\alpha$

$\alpha = 19.47°$

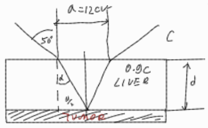
$\Delta ABC \Rightarrow \cos\alpha = \frac{h}{\ell}$

$\Rightarrow \ell = \frac{h}{\cos\alpha}$

$\Delta CD \Rightarrow \sin(10.53)° = \frac{d}{\ell}$

$d = \ell(0.18)$

$d = \frac{h}{\cos(19.47°)} 0.18 = h \frac{0.18}{0.95} = 0.38\,cm$

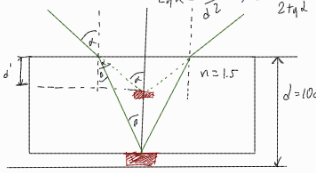


$n = \frac{\ell}{0.9\ell} = 1.11$

$1 \sin 50° = n \sin\alpha$

$\alpha = 43.6°$

$tg\alpha = \frac{a}{d\,2} \Rightarrow d = \frac{a}{2 tg\alpha} = 6.3\,cm$



$1 \sin\alpha = n \sin\beta$

$tg\beta = \frac{x}{d} \quad tg\alpha = \frac{x}{d'}$ } $\Rightarrow$ $\alpha \ll 1 \quad \sin\alpha \simeq \tan\alpha \simeq \alpha$

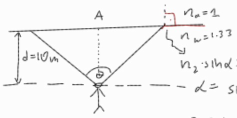
$\alpha = n\beta$

$\beta = \frac{x}{d}$

$\alpha = \frac{x}{d'}$

$\frac{x}{d'} = n\frac{x}{d}$

$d' = nd$



$n_2 \cdot \sin\alpha \geq n_2$

$n_2 \cdot \sin\alpha = n_2$

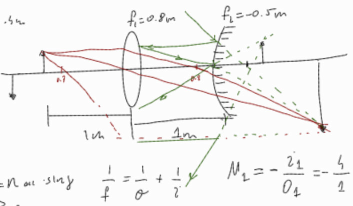
$\alpha = \sin^{-1}\left(\frac{n_a}{n_w}\right) = 48.75°$

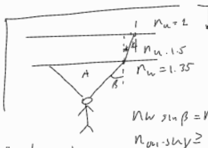
$\theta = 2\alpha = 97.5°$

$\tan\alpha = \frac{r}{d}$

$\Rightarrow r = d \cdot \tan\alpha = 10 \cdot 1.14 = 11.5\,m$

$A = r^2 \cdot \pi = 408.3\,m^2$





$n_w \sin\beta = n_{air} \sin\gamma$

$n_{air} \cdot \sin\gamma \geq n_a$

$n_w \sin\beta \geq n_a$

$\beta \geq \sin^{-1}\frac{n_a}{n_w} = 48.75°$

$\Rightarrow \theta = 97.5°$

it does not change.

$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$ $\qquad M_1 = -\frac{i_1}{o_1} = -\frac{4}{1} = -4$

$\frac{1}{f_1} = \frac{1}{o_1} + \frac{1}{i_1}$

$\frac{1}{i_1} = \frac{1}{f_1} - \frac{1}{o_1} = \frac{o_1 - f_1}{f_1 o_1}$

$i_1 = \frac{f_1 o_1}{o_1 - f_1} = \frac{0.8 \cdot 1}{1 - 0.8} = \frac{0.8}{0.2} = 4$

$\frac{1}{f_2} = \frac{1}{o_2} + \frac{1}{i_2}$

$i_2 = d - i_1 = 1 - 5 = -3\,m$

$i_2 = \frac{f_2 o_2}{o_2 - f_2} = \frac{(-0.5)(-3)}{(-3)-(-0.5)} = -\frac{1.5}{2.5} = -0.6\,m$

$M_2 = -\frac{i_2}{o_2} = -\frac{-0.6}{-3} = -0.2$

$\frac{1}{f_1} = \frac{1}{o_3} + \frac{1}{i_3}$

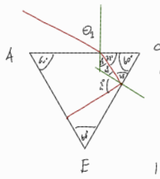
$o_3 = d - i_2 = 1 - (-0.6) = 1.6\,m$

$i_3 = \frac{f_1 o_3}{o_3 - f_1} = \frac{0.8(1.6)}{1.6 - 0.8} = 1.6\,m$

$M_3 = -\frac{i_3}{o_3} = -1$

$M = m_1 \cdot m_2 \cdot m_3 = (-4)(-0.2)(-1)$

$M = -0.8$



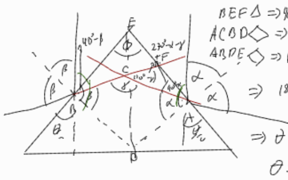
$n \cdot \sin 42° = 1$

$n = \frac{1}{\sin 42°} = 1.49$

$n \sin\beta = 1 \sin\theta_1$

$1.49 \sin(18°) = \sin\theta_1$

$\theta_1 = 27.42°$



$BEF\Delta \Rightarrow \cancel{90°} + \phi + 270° - \alpha - \gamma = 180°$

$ACOD\Diamond \Rightarrow \alpha + \phi + \gamma + \phi = 360°$ I,

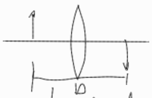
$ABDE\Diamond \Rightarrow 180° + \phi + \alpha = 360°$ I$_2$

$\Rightarrow 180° - \alpha - \beta - \gamma + \phi = 0°$ III

$\Rightarrow \theta = 90° - \beta + 90° - \alpha$

$\theta = 180° - \beta - \alpha$ IV

IV - III $= -\phi + \gamma = \phi \quad \gamma = 2\phi$



$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$

$\frac{1}{i} = \frac{1}{f} - \frac{1}{o} = \frac{f\,o}{o - f}$

$i = \frac{fo}{o-f}$ $\quad D = o + i$

$D = o + \frac{fo}{o-f} = \frac{o^2 - \cancel{of} + \cancel{of}}{o-f}$

$D = \frac{o^2}{o-f}$

$\frac{dD}{do} = \frac{2o(o-f) - o^2}{(o-f)^2} = 0$

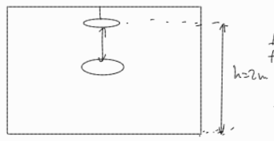
$2o(o-f) - o^2 = 0$

$2o^2 - 2of - o^2 = 0$

$o^2 - 2of = 0$

$o(o - 2f) = 0$

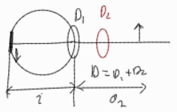
$o - 2f = 0 \Rightarrow o = 2f \Rightarrow i = 2f$

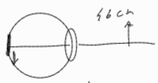


$i + o = 2h$

$\frac{1}{f} = \frac{1}{o} + \frac{1}{i} = \frac{1}{o} + \frac{1}{h-o} = \frac{h}{ho - o^2}$

$f = \frac{ho - o^2}{h} \quad 4f \leq h$



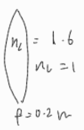


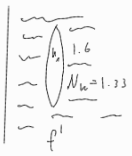
$D_1 = \frac{1}{o_1} + \frac{1}{i}$ I

$D_1 + D_2 = \frac{1}{o_2} + \frac{1}{i}$ II

II - I : $D_2 = \frac{1}{o_2} - \frac{1}{o_1}$

$D_2 = \frac{1}{0.25} - \frac{1}{0.46} = 1.82$



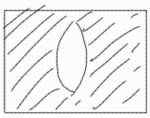


$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$n = \frac{n_\ell}{n_a}$

$\frac{1}{f} = \frac{n_\ell - n_a}{n_a}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ I

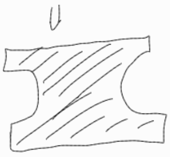
$\frac{1}{f'} = \frac{n_\ell - n_w}{n_w}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ II



I / II $= \frac{f'}{f} = \frac{(n_\ell - n_a) n_w}{n_a(n_\ell - n_w)}$

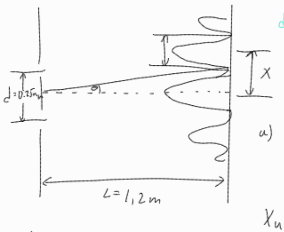
$f' = \frac{(0.6)\,1.33}{(0.27)} \cdot 0.2 = 0.6\,m$

$\Downarrow$



$f'' = -\frac{1.72(0.6)}{0.12} \cdot 0.2 = -2\,m$

1)



$d\sin\theta$ — $m\lambda$ BRIGHT; $(m+\frac{1}{2})\lambda$ DARK $\quad m \in \mathbb{Z}$

$\theta << 1 \quad \sin\theta \simeq tg\theta = \frac{X}{L}$

a) $d \cdot \frac{X_m}{L} \approx m\lambda$

$X_m = \frac{m\lambda L}{d}$

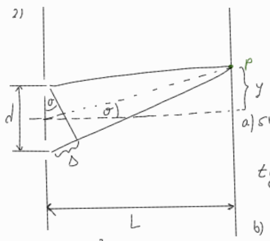
$\lambda = 536,1nm$

$X_u = X_1 = \frac{(1)(536,1)(10^{-9})\cdot(1.2)}{(2.5)\ (10^{-4})} = 262 \cdot 10^{-5} = 2.6\ mm$

b) $d\frac{X'_m}{L} = \left(m+\frac{1}{2}\right)\lambda \Rightarrow X'_m = \frac{L}{d}\left(m+\frac{1}{2}\right)\lambda$

$X_b = X'_2 - X'_1 = \left(\left(2+\frac{1}{2}\right) - \cancel{\left(1+\frac{1}{2}\right)}\right)\frac{L\lambda}{d} = 2.6mm$ $\quad 1$

2)



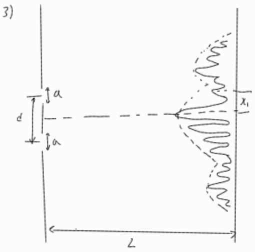
a) $\sin\theta = \frac{\Delta}{d} \Rightarrow \Delta = d\cdot\sin\theta = 1.928\cdot 10^{-6}m$ $\qquad d\frac{y}{L} = \Delta$

$tg\,\theta = \frac{y}{L} = \frac{1.8\cdot10^{-2}}{1.4} \Rightarrow \theta = 0.7366°$

b) $\frac{\Delta}{\lambda} = \frac{1.929\cdot10^{-6}}{643\cdot10^{-9}} = 3$ $\qquad$ c) BRIGHT

$y = 1.8\cdot10^{-2}m$
$L = 1.4m$
$\lambda = 643\cdot10^{-9}m$
$d = 1.5\cdot10^{-4}m$

3)



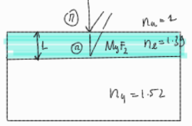
$X_1 = 2mm$
$L = 1m$
$\lambda = 500\ nm$
$d = ?$
$a = ?$
$m\lambda = d\sin\theta$ BRIGHT
$m\lambda = a\sin\theta$ DARK

$m\lambda = d\frac{X}{L} \Rightarrow d = \frac{Lm\lambda}{X} = \frac{(1)(5)(10^{-7})}{2\cdot10^{-3}} = 2.5\cdot10^{-5}m = 0.25mm$

$X_5 = 5X_1 = 1cm$

$m\lambda = a\frac{X'_m}{L} \Rightarrow a = \frac{m\lambda L}{X'_m} = \frac{(1)(5)(10^{-7})(1)}{10^{-2}} = 5\cdot10^{-5} = 0.05mm$

4)



$2n_e L\cos\beta = m\lambda$ CONST
$= \frac{2m+1}{2}\lambda$ DESTR.

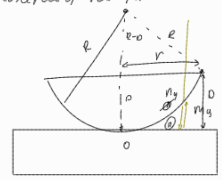
$\alpha = 0° \Rightarrow \beta = 0°$

a) $n_e 2n = \frac{\lambda}{2}$ $\qquad L = \frac{\lambda}{4n_e} = \frac{(5.5)(10^{-7})}{(4)(1.38)} = 98\ nm$

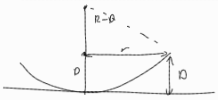
b) $m \in \mathbb{Z}$
$m_1 \Rightarrow L_1 = 3L \Rightarrow \dots$
$m_2 \Rightarrow L_2 = 5L \Rightarrow \dots$ numerical
$m_3 \Rightarrow L_3 = 7L \Rightarrow \dots$

Koherence of the light is the max limit of the optical path differenc

5)



$R = 5cm = 5\cdot10^{-2}m$
$\lambda = 650nm = 650\cdot10^{-9}$
$N = 55$
$n = 1.52$
$2n_e L\cos\beta = m\lambda$ DESTRUCT
$= \frac{2m+1}{2}\lambda$ CONSTRUC



$(2)(1)(D)(1) = \frac{(2)(55)+1}{2}(650)(10^{-9})$
$= 27.75\cdot650\cdot10^{-9}$
$= 1.8\cdot10^{-5}m$

$(R-D)^2 + r^2 = R^2$

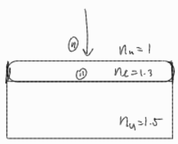
$\cancel{R^2} - 2RD + D^2 + r^2 = \cancel{R^2}$

$R = \frac{D^2+r^2}{2D} = \frac{\cancel{3.24\cdot10^{-10}} + 25\cdot10^{-4}}{3.6\cdot10^{-5}} = 6.94\cdot10 = 69.4m$

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \cancel{\frac{1}{R_2}}\right)$ $\quad R_2 = \infty$

$\frac{1}{f} = (n-1)\left(\frac{1}{R_1}\right)$

$2n_e d\cos\beta = n\lambda$
$= \frac{2m+1}{2}\lambda$



$2n_e d\cos\beta = m\lambda$ CONSTR λ_1
$= \frac{2m+1}{2}\lambda$ DESTRUC λ_1

$2n_e \leq$ koherence length

$2n_e d = m\lambda_1$ $\quad m, \ell \in \mathbb{Z}$
$2n_e d = \frac{2\ell+1}{2}\lambda_1$
$m\lambda_1 = \frac{2\ell+1}{2}\lambda_2$
$\frac{\lambda_1}{\lambda_2} = \frac{\frac{2\ell+1}{2}}{m} = \frac{2\ell+1}{2m}$

$\lambda_1 = 500\ nm$ STRONG REFLECTION
$\lambda_2 = 600\ nm$ WEAK REFLECTION

ℓ	2	7	12
m	3	9	15
d	577nm	3·d	5·d

$\frac{5}{6} = \frac{2\ell+1}{2m}$