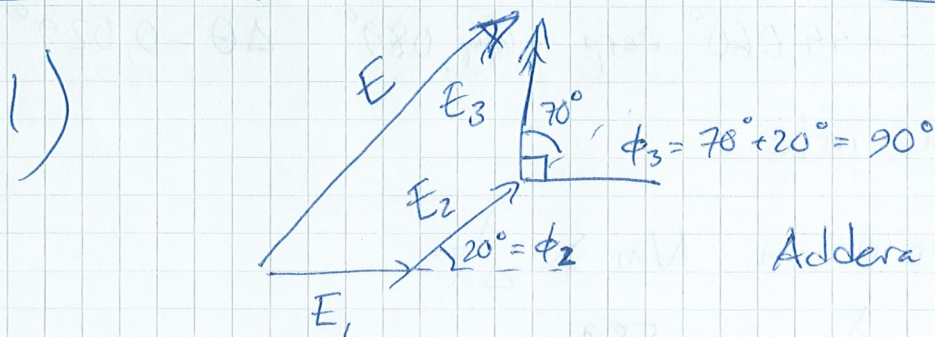


Lösningar tentz 070605 /EL



Addera faservektorer

$$E^2 = (E_1 + E_2 \cos \phi_2)^2 + (E_2 \sin \phi_2 + E_3)^2$$

$$I \propto E^2$$

$$\begin{aligned} I &= (\sqrt{I_1} + \sqrt{I_2} \cos \phi_2)^2 + (\sqrt{I_2} \sin \phi_2 + \sqrt{I_3})^2 \\ &= (\sqrt{2} + \sqrt{3} \cos 20^\circ)^2 + (\sqrt{3} \sin 20^\circ + \sqrt{5})^2 \text{ mW/cm}^2 \\ &= \underline{\underline{19}} \text{ mW/cm}^2 \end{aligned}$$

2) Transmissionsgitter

$$d(\sin \theta + \sin i) = m\lambda \quad m = 0, \pm 1, \pm 2, \dots$$

$$d = \frac{10 \text{ mm}}{6000} \quad i = 20^\circ$$

$$\lambda_1 = 588,9953 \text{ nm}, \quad \lambda_2 = 589,5923 \text{ nm}$$

$$m=0 \quad \theta_0 = -20^\circ \text{ för båda linjerna}$$

$$m=1 \quad \theta_1 = 0,652^\circ \text{ resp } 0,672^\circ \quad \Delta\theta = 0,021^\circ$$

$$m=2 \quad \theta_2 = 21,394^\circ \text{ resp } 21,438^\circ \quad \Delta\theta = 0,044^\circ$$

$$m=3 \quad \theta_3 = 45,904^\circ \text{ resp } 45,992^\circ \quad \Delta\theta = 0,089^\circ$$

$$m=4 \quad \text{finns inte}$$

2 forts.

$$m = -1 \quad \theta_1 = -44,060^\circ \text{ resp } -44,089^\circ \quad \Delta\theta = 0,029^\circ$$

$m = -2$ finns inte

$$\text{Upplösningskriterium} \quad Nm > \frac{\lambda}{\Delta\lambda}$$

$$\Rightarrow m > \frac{\lambda}{N\Delta\lambda} = \frac{589}{6000 \cdot 0,6} = 0,16$$

$\therefore$ alla linjer utom $m=0$ upplösta!

3) Linsmakerformeln

$$\text{Lins 1: } \frac{1}{f_1} = (n-1) \left(\frac{1}{r_1} + \frac{1}{r_2} \right) = 0,52 \cdot \left(\frac{1}{0,4\text{m}} + \frac{1}{0,4\text{m}} \right)$$

$$\Rightarrow f_1 = -0,385\text{m}$$

$$\text{Lins 2: } \frac{1}{f_2} = 0,52 \left(\frac{1}{0,3\text{m}} - \frac{1}{1\text{m}} \right) \Rightarrow f_2 = 0,824\text{m} \\ (\text{positiv.})$$

Arbildning i lins 2

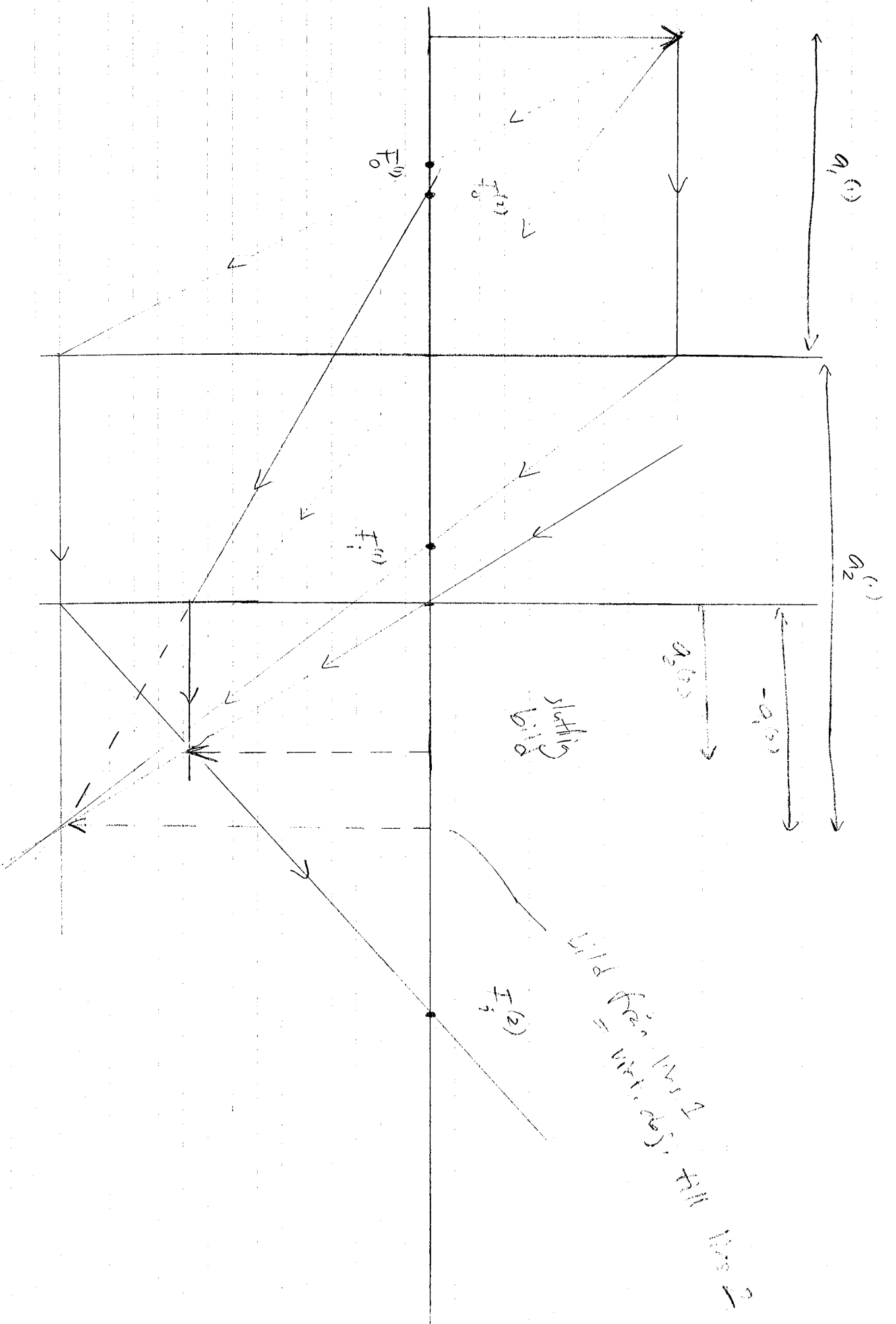
$$\frac{1}{a_1^{(2)}} + \frac{1}{30\text{cm}} = \frac{1}{0,824\text{m}} \Rightarrow a_1^{(2)} = -0,472\text{m} \text{ virtuellt objekt}$$

$$\text{Bildavstånd lins 1: } a_2^{(1)} = 0,5\text{m} - (-0,472\text{m}) = 0,972\text{m}$$

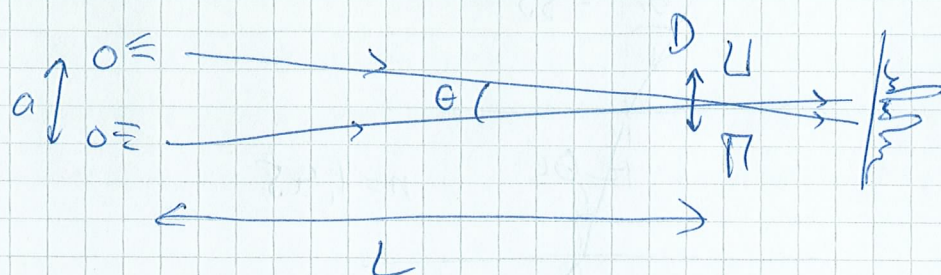
Arbildning i lins 1

$$\frac{1}{a_1^{(1)}} + \frac{1}{0,972\text{m}} = \frac{1}{-0,385\text{m}} \Rightarrow \underline{a_1^{(1)} = 0,638\text{m}}$$

Svar: $0,638\text{m} = 0,64\text{m}$ framför första linsen.



4)



Antag: Avstånd mellan lyktor på bil $a = 1,5 \text{ m}$

Pupillens diameter $D = 3 \text{ mm}$

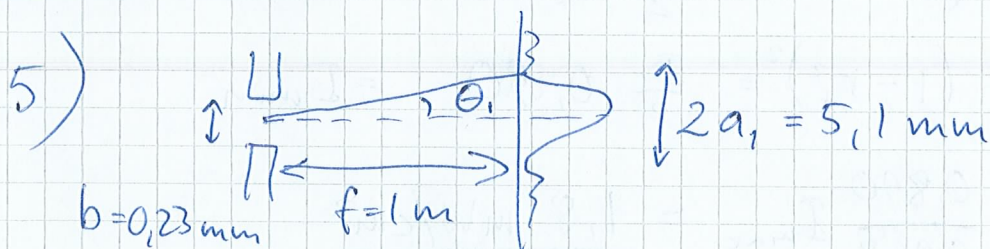
Mitt i synligt spektrum $\lambda = 550 \text{ nm}$

Rayleighs upplösningskriterium

$$\Theta = 1,22 \frac{\lambda}{D} = 2,2 \cdot 10^{-4} \text{ rad (liten vinkel)}$$

Ur figur: $L = \frac{a}{\Theta} = 7000 \text{ m}$

Svar: ca 7 km

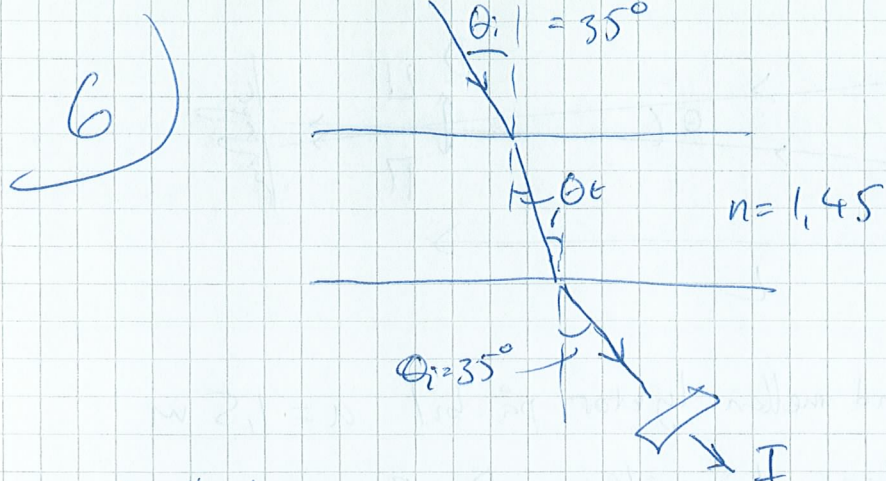


Intensitetsminimum $b \sin \Theta_1 = 1 \cdot \lambda$

och ur figur $\Theta_1 = \arctan \frac{a_1}{f}$

$$\therefore \lambda = b \sin \arctan \frac{a_1}{f} = 5,9 \cdot 10^{-7} \text{ m}$$

Svar 590 nm



Snells lag

$$\theta_t = \arcsin(\sin \theta_i / n) = 23.3^\circ$$

$$r_{||} = -\frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)} = -0.1279$$

$$r_{\perp} = -\frac{\sin(\theta_i - \theta_t)}{\sin(\theta_i + \theta_t)} = -0.2383$$

Trä ytor med samma reflektans

Total transmitterad irradians blir

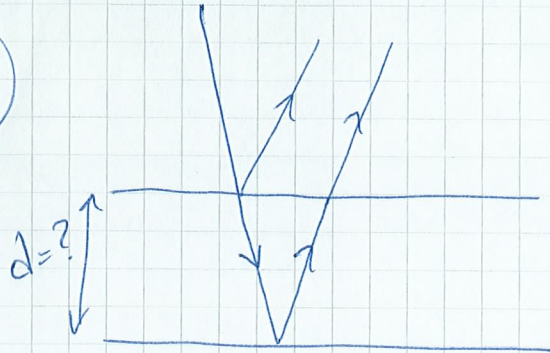
$$I_{||} = \frac{I_0}{2} \cdot (1 - r_{||}^2)^2 = \frac{I_0}{2} \cdot 0.968 = I_{\max} = 2.0 \text{ mW/cm}^2$$

$$I_{\perp} = \frac{I_0}{2} \cdot (1 - r_{\perp}^2)^2 = \frac{I_0}{2} \cdot 0.890 = I_{\min}$$

$$I_{\min} = \frac{0.890}{0.968} I_{\max} = \underline{\underline{1.8 \text{ mW/cm}^2}}$$

$I_{\min} = I_{\perp}$ då står polarisatorn $\perp$ mot infallsplanet

7)



Luft $n=1$

MgF_2 $n_1 = 1,38$

Glas $n_2 = 1,80$

$n_2 > n_1 > 1 \Rightarrow$ två externa reflektioner
 $\Rightarrow$ inget fasskift.

Optisk vägskillnad $\Delta L = 2n_1 d = (m + \frac{1}{2})\lambda$, $m=0,1,2,\dots$

Minsta tjocklek fås för $m=0$:

$$d = \frac{\lambda/2}{2n_1} = \frac{589 \text{ nm}}{4 \cdot 1,38} = \underline{\underline{0,107 \mu\text{m}}}$$

Även detta multiplicerat med 3,5,7,9,... går bra

b) Man måste veta att $n_2 > n_1$ för att kunna fastställa vad fasskiftet blir. Alltså behövs alla tre värdena.

