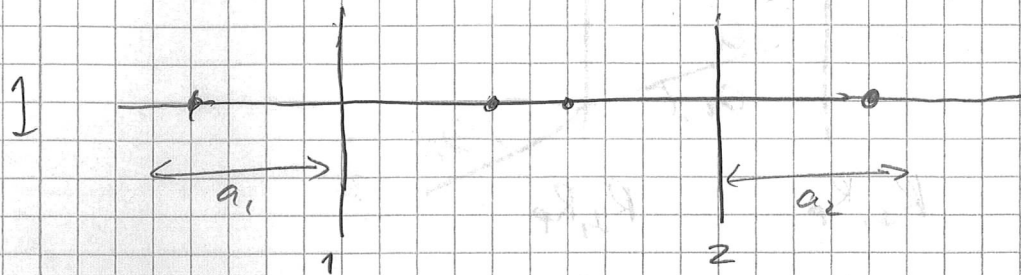


# 080827 Lösningar



Förstärkning

$$g = M = M_1 M_2$$

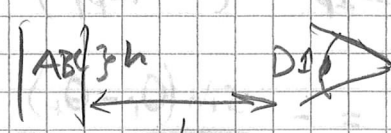
$$= \frac{f_1}{f_2} \frac{a_2 - f_2}{a_1 - f_1} \quad (\text{PH.})$$

$$\frac{a_2 - 4}{a_1 - 4} = g \Rightarrow a_1 = a_2$$

$$s = \frac{a_1 f_1}{a_1 - f_1} + \frac{a_2 f_2}{a_2 - f_2} \quad (\text{PH.})$$

$$\frac{s}{f} = 2,5 = \frac{a_1/f_1}{a_1/f_1 - 1} + \frac{a_2/f_2}{a_2/f_2 - 1} = \frac{2a/f}{a/f - 1}$$

$$2,5 \frac{a}{f} - 2,5 = \frac{2a}{f} \Rightarrow \frac{1}{2} \frac{a}{f} = 2,5 \Rightarrow \underline{\underline{a = 5f = 20 \text{ cm}}}$$

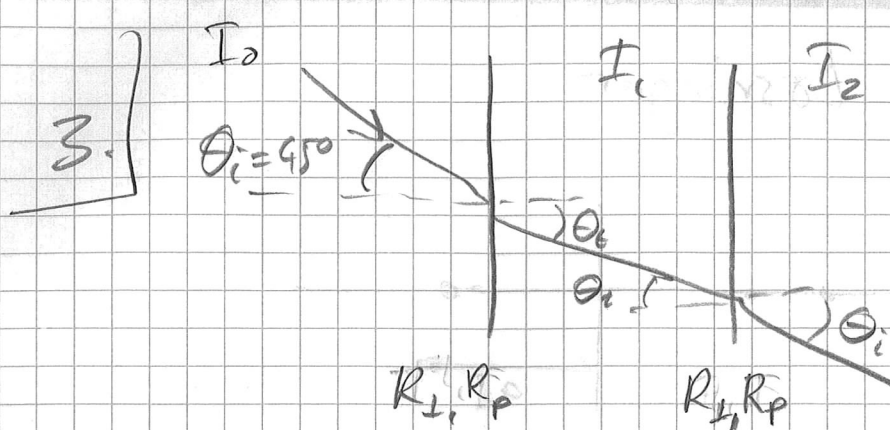
2 Rayleigh  $\varphi_r = 1,22 \frac{\lambda}{D}$  

Tag  $\lambda = 550 \text{ nm}$ ,  $D = 4 \text{ mm}$  (pupill)

$$\varphi_r = \frac{h}{L} \quad \text{tag} \quad h = 2 \text{ mm}$$

$$L = \frac{h}{1,22 \lambda / D} = \frac{2 \cdot 4 \cdot 10^{-3} \cdot 10^{-3}}{1,22 \cdot 550 \cdot 10^{-9}} \text{ m} = 10 \cdot \frac{8}{5,5 \cdot 1,22} \text{ m} = \underline{\underline{1,2 \text{ m}}}$$

Antaganden för  $D$ ,  $\lambda$  och  $h$  får variera inom rimliga gränser.



Försumma multipla reflektioner.

Räkna alltid med reflektionskoefficienten:

Snell  $\theta_t = \arcsin\left(\frac{1}{n} \sin \theta_i\right) \approx 28,13^\circ$

$$R_{p1} = -\frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)} \approx -0,0920$$

Transmitterad irradians första ytan = ?

Antag initial irradians är  $I_0$ . Då är den  $I_0/2$  för varje polarisationskomponent.

$$I_{2p} = (1 - R_{p1}^2) \frac{I_0}{2} \approx 0,9915 \frac{I_0}{2}$$

Andra ytan:  $R_{p2} = -R_{p1}$

$$I_{2p} = (1 - R_{p1}^2)^2 \frac{I_0}{2} \approx 0,9831 \frac{I_0}{2}$$

$$R_{\perp 1} = -\frac{\sin(\theta_i - \theta_t)}{\sin(\theta_i + \theta_t)} \approx -0,3033$$

$$I_{2\perp} = (1 - R_{\perp 1}^2)^2 \frac{I_0}{2} = 0,8244 \frac{I_0}{2}$$

Givet att  $0,9831 \frac{I_0}{2} = 5,0 \text{ W/cm}^2 = I_{\max}$

Då blir  $I_{\min} = \frac{0,8244}{0,9831} I_{\max} = \underline{\underline{4,2 \text{ W/cm}^2}}$

4) Se boken.

5. | 
$$I = I_0 \left( \frac{\sin \beta/2}{\beta/2} \right)^2 \left( \frac{\sin N\delta/2}{\sin \delta/2} \right)^2$$

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

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

$$\Rightarrow \sin \theta = \frac{781 \text{ nm}}{60 \mu\text{m}} \cdot (m + \frac{1}{2}) =$$

0,0065	(m=0)
0,0195	1
0,0325	2
0,0456	3

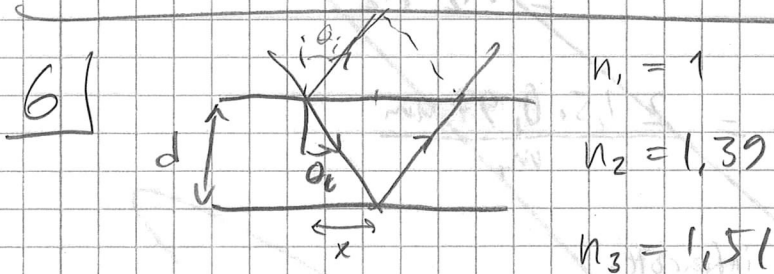
Å andra sidan är första diffraktionsmin:

$b \sin \theta = m\lambda \Rightarrow \sin \theta =$

0,03905	m=1
0,078	m=2

Fyra första märka är:  $(h = f \tan \theta \approx f \sin \theta)$   
 $f = 550 \text{ mm}$

m=0, int:	3,6 mm
m=1, int:	10,7 mm
m=2, int:	17,9 mm
m=1, diff:	21,5 mm



Obs! Ph. formel "Interference in thin films" kan ej användas direkt

Snell  $\theta_r = \arcsin \left( \frac{n_1}{n_2} \sin \theta_i \right) \approx 10,73^\circ$



6, forts

$$\tan \theta_t = \frac{x}{d}$$

$$\sin \theta_i = \frac{x}{OVL_1} \Rightarrow OVL_1 = \frac{d \tan \theta_t}{\sin \theta_i} = d \cdot 0,7322$$

$$OVL_2 = 2 \cdot \frac{d}{\cos \theta_t} = d \cdot 2,0356$$

$$\Lambda = OVL_2 - OVL_1 = d \left( \frac{2}{\cos \theta_t} - \frac{\tan \theta_t}{\sin \theta_i} \right)$$

Fasstillnad:  $\delta = 2n \frac{\Lambda}{\lambda} + 0$  (ty två externa refl.)

$$= m \cdot 2\pi \text{ för max refl}$$

$$d \left( \frac{2}{\cos \theta_t} - \frac{\tan \theta_t}{\sin \theta_i} \right) = m \lambda$$

$$\Rightarrow d = m \cdot \frac{589 \text{ nm}}{2,03 - 0,73} = \underline{\underline{m \cdot 452 \text{ nm}}}$$

dar m heltal

~~7~~

~~Diagram of a thin film interference setup showing incident light, reflection, and transmission through a film of thickness  $d$  and refractive index  $n$ .~~

~~Equations for path difference and phase shift:~~

$$\Delta = 2nd \cos \theta_t$$

$$\Delta = m \lambda$$

~~Additional calculations and notes:~~

~~$n = 1,5$~~

~~$\lambda = \frac{589 \text{ nm}}{m}$~~

~~$m = 3: 970 \text{ nm} - \text{infra rött}$~~

~~$m = 2: 485 \text{ nm} - \text{synligt}$~~

~~$m = 1: 582 \text{ nm} - \text{synligt}$~~

~~$\lambda = 589 \text{ nm}$~~

~~$\Delta = 2nd \cos \theta_t = m \lambda$~~

~~$\Delta = 2 \cdot 1,5 \cdot d \cdot \cos \theta_t = m \lambda$~~

~~$d = \frac{m \lambda}{2 \cdot 1,5 \cdot \cos \theta_t}$~~

~~$d = \frac{m \cdot 589 \text{ nm}}{3 \cdot \cos \theta_t}$~~

~~$d = \frac{m \cdot 589 \text{ nm}}{3 \cdot 0,73}$~~

~~$d = \frac{m \cdot 589 \text{ nm}}{2,19}$~~

~~$d = m \cdot 270 \text{ nm}$~~

~~$m = 1: 270 \text{ nm}$~~

~~$m = 2: 540 \text{ nm}$~~

~~$m = 3: 810 \text{ nm}$~~

~~$m = 4: 1080 \text{ nm}$~~

~~$m = 5: 1350 \text{ nm}$~~

~~$m = 6: 1620 \text{ nm}$~~

~~$m = 7: 1890 \text{ nm}$~~

~~$m = 8: 2160 \text{ nm}$~~

~~$m = 9: 2430 \text{ nm}$~~

~~$m = 10: 2700 \text{ nm}$~~

~~$m = 11: 2970 \text{ nm}$~~

~~$m = 12: 3240 \text{ nm}$~~

~~$m = 13: 3510 \text{ nm}$~~

~~$m = 14: 3780 \text{ nm}$~~

~~$m = 15: 4050 \text{ nm}$~~

~~$m = 16: 4320 \text{ nm}$~~

~~$m = 17: 4590 \text{ nm}$~~

~~$m = 18: 4860 \text{ nm}$~~

~~$m = 19: 5130 \text{ nm}$~~

~~$m = 20: 5400 \text{ nm}$~~

~~$m = 21: 5670 \text{ nm}$~~

~~$m = 22: 5940 \text{ nm}$~~

~~$m = 23: 6210 \text{ nm}$~~

~~$m = 24: 6480 \text{ nm}$~~

~~$m = 25: 6750 \text{ nm}$~~

~~$m = 26: 7020 \text{ nm}$~~

~~$m = 27: 7290 \text{ nm}$~~

~~$m = 28: 7560 \text{ nm}$~~

~~$m = 29: 7830 \text{ nm}$~~

~~$m = 30: 8100 \text{ nm}$~~

~~$m = 31: 8370 \text{ nm}$~~

~~$m = 32: 8640 \text{ nm}$~~

~~$m = 33: 8910 \text{ nm}$~~

~~$m = 34: 9180 \text{ nm}$~~

~~$m = 35: 9450 \text{ nm}$~~

~~$m = 36: 9720 \text{ nm}$~~

~~$m = 37: 9990 \text{ nm}$~~

~~$m = 38: 10260 \text{ nm}$~~

~~$m = 39: 10530 \text{ nm}$~~

~~$m = 40: 10800 \text{ nm}$~~

~~$m = 41: 11070 \text{ nm}$~~

~~$m = 42: 11340 \text{ nm}$~~

~~$m = 43: 11610 \text{ nm}$~~

~~$m = 44: 11880 \text{ nm}$~~

~~$m = 45: 12150 \text{ nm}$~~

~~$m = 46: 12420 \text{ nm}$~~

~~$m = 47: 12690 \text{ nm}$~~

~~$m = 48: 12960 \text{ nm}$~~

~~$m = 49: 13230 \text{ nm}$~~

~~$m = 50: 13500 \text{ nm}$~~

~~$m = 51: 13770 \text{ nm}$~~

~~$m = 52: 14040 \text{ nm}$~~

~~$m = 53: 14310 \text{ nm}$~~

~~$m = 54: 14580 \text{ nm}$~~

~~$m = 55: 14850 \text{ nm}$~~

~~$m = 56: 15120 \text{ nm}$~~

~~$m = 57: 15390 \text{ nm}$~~

~~$m = 58: 15660 \text{ nm}$~~

~~$m = 59: 15930 \text{ nm}$~~

~~$m = 60: 16200 \text{ nm}$~~

~~$m = 61: 16470 \text{ nm}$~~

~~$m = 62: 16740 \text{ nm}$~~

~~$m = 63: 17010 \text{ nm}$~~

~~$m = 64: 17280 \text{ nm}$~~

~~$m = 65: 17550 \text{ nm}$~~

~~$m = 66: 17820 \text{ nm}$~~

~~$m = 67: 18090 \text{ nm}$~~

~~$m = 68: 18360 \text{ nm}$~~

~~$m = 69: 18630 \text{ nm}$~~

~~$m = 70: 18900 \text{ nm}$~~

~~$m = 71: 19170 \text{ nm}$~~

~~$m = 72: 19440 \text{ nm}$~~

~~$m = 73: 19710 \text{ nm}$~~

~~$m = 74: 19980 \text{ nm}$~~

~~$m = 75: 20250 \text{ nm}$~~

~~$m = 76: 20520 \text{ nm}$~~

~~$m = 77: 20790 \text{ nm}$~~

~~$m = 78: 21060 \text{ nm}$~~

~~$m = 79: 21330 \text{ nm}$~~

~~$m = 80: 21600 \text{ nm}$~~

~~$m = 81: 21870 \text{ nm}$~~

~~$m = 82: 22140 \text{ nm}$~~

~~$m = 83: 22410 \text{ nm}$~~

~~$m = 84: 22680 \text{ nm}$~~

~~$m = 85: 22950 \text{ nm}$~~

~~$m = 86: 23220 \text{ nm}$~~

~~$m = 87: 23490 \text{ nm}$~~

~~$m = 88: 23760 \text{ nm}$~~

~~$m = 89: 24030 \text{ nm}$~~

~~$m = 90: 24300 \text{ nm}$~~

~~$m = 91: 24570 \text{ nm}$~~

~~$m = 92: 24840 \text{ nm}$~~

~~$m = 93: 25110 \text{ nm}$~~

~~$m = 94: 25380 \text{ nm}$~~

~~$m = 95: 25650 \text{ nm}$~~

~~$m = 96: 25920 \text{ nm}$~~

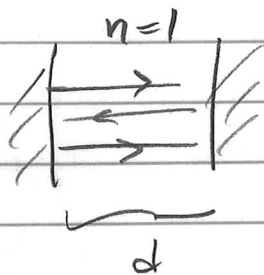
~~$m = 97: 26190 \text{ nm}$~~

~~$m = 98: 26460 \text{ nm}$~~

~~$m = 99: 26730 \text{ nm}$~~

~~$m = 100: 27000 \text{ nm}$~~

7.)



$$\lambda_1 = 550 \text{ nm}$$

$$2nd = m \cdot \lambda_1$$

$$\Rightarrow d = \frac{m \lambda_1}{2n} = m \cdot \frac{550 \text{ nm}}{2 \cdot 1} = m \cdot 275 \cdot 10^{-7} \text{ m}$$

för transmission av 550 nm

Nästa transmissionsstopp måste ligga på

$$\lambda < \lambda_2 = 400 \text{ nm}$$

$$2nd = (m+1) \lambda < (m+1) \lambda_2$$

$$2n \cdot m \cdot \frac{\lambda_1}{2n} < (m+1) \lambda_2$$

$$m \cdot (\lambda_1 - \lambda_2) < \lambda_2 \Rightarrow m < \frac{\lambda_2}{\lambda_1 - \lambda_2} = \frac{400}{550 - 400} = 2,7$$

Föregående topp måste ligga på  $\lambda > \lambda_3 = 800 \text{ nm}$

$$2nd = (m-1) \lambda > (m-1) \lambda_3$$

$$m \cdot \lambda_1 > (m-1) \lambda_3 \Rightarrow m(\lambda_3 - \lambda_1) < \lambda_3$$

$$\Rightarrow m < \frac{800}{800 - 550} = 3,2$$

Första olikheten är strängast och alltså kräver vi

$$\underline{m \leq 2}$$

$$\underline{d = 550 \text{ nm}}$$

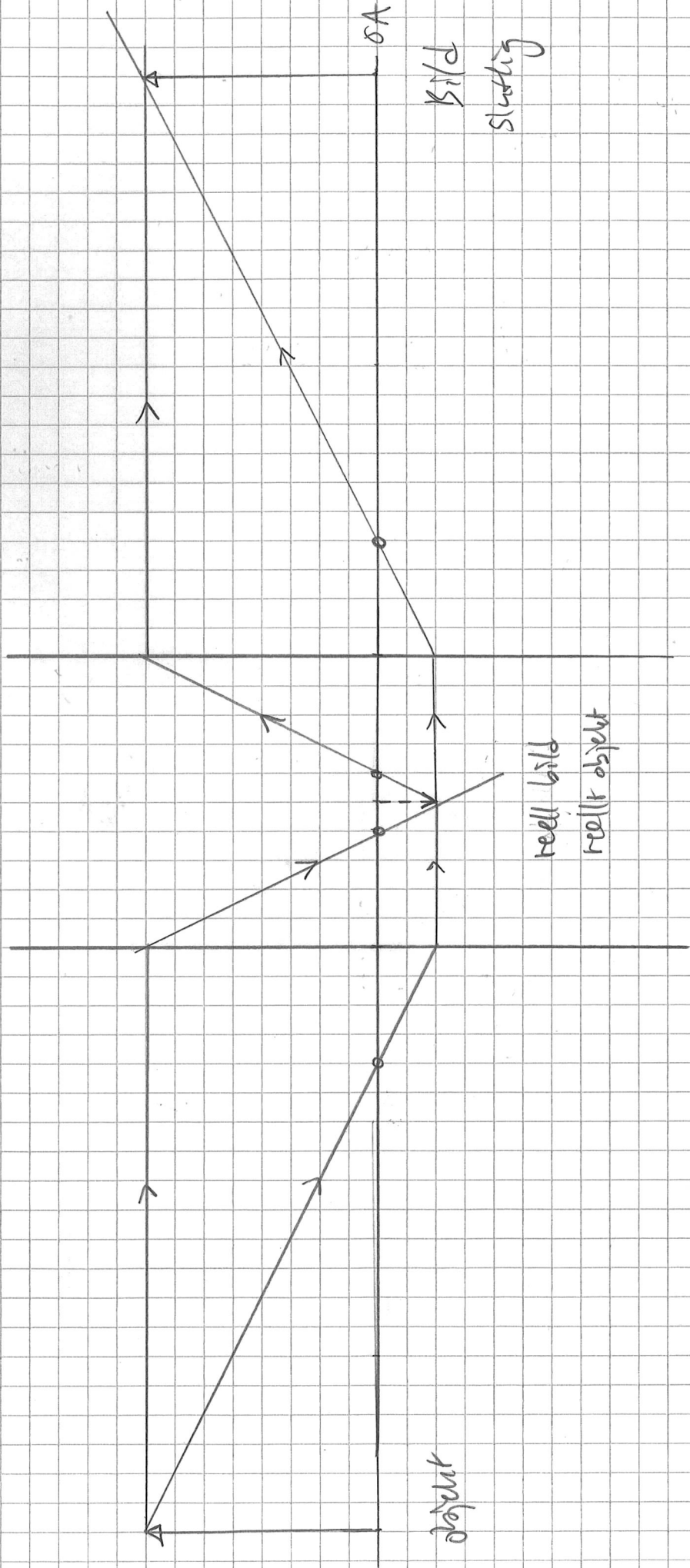


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