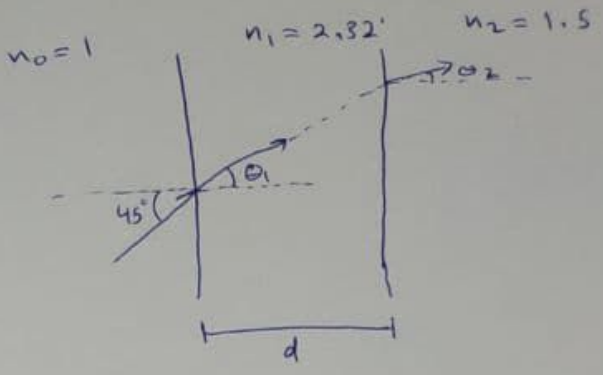
P4.5

$$T_s = \frac{T_s^{max}}{1 + F_s \sin^2\left(\frac{\Phi_s}{2}\right)}$$

$$T_s^{max} = \frac{T_s^{0\to1}\, T_s^{1\to2}}{\left(1 - \sqrt{R_s^{0\leftarrow1}\, R_s^{1\to2}}\right)^2}$$

$$\Phi_s = 2k_1 d\cos\theta_1 + \phi_{rs}^{0\leftarrow1} + \phi_{rs}^{1\to2}$$

$$F_s = \frac{4\sqrt{R_s^{0\leftarrow1}\, R_s^{1\to2}}}{\left(1 - \sqrt{R_s^{0\leftarrow1}\, R_s^{1\to2}}\right)^2}$$



$$n_0 \sin\theta_0 = n_1 \sin\theta_1$$

$$\frac{1}{\sqrt{2}} = (2.32)\sin\theta_1$$

$$\Rightarrow \boxed{\theta_1 = 17.75°}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\Rightarrow \boxed{\theta_2 = 28.13°}$$

$$R_s^{0\leftarrow1} = |r_s^{0\leftarrow1}|^2 = \left|\frac{-\sin(45 - 17.75)}{\sin(45 + 17.45)}\right|^2$$

$$\Rightarrow \boxed{R_s^{0\leftarrow1} = 0.26526}$$

$$T_s^{0\to1} = T_s^{0\leftarrow1} = 1 - R_s^{0\leftarrow1}$$

$$\Rightarrow \boxed{T_s^{0\to1} = 0.73474}$$

$$R_s^{1\to2} = |r_s^{1\to2}|^2 = \left|\frac{\sin(28.13 - 17.75)}{\sin(28.13 + 17.45)}\right|^2$$

$$\Rightarrow \boxed{R_s^{1\to2} = 0.063}$$

$$T_s^{1\to2} = 1 - R_s^{1\to2}$$

$$\Rightarrow \boxed{T_s^{1\to2} = 0.937}$$

$$\boxed{T_s^{max}} = \frac{0.73474 \times 0.937}{\left(1 - \sqrt{0.26526 \times 0.063}\right)^2} = 0.908$$

$$\Phi_s = \frac{2}{\sqrt{2}} \frac{2\pi(2.32)}{\lambda_{vac}} d + 0 + 0$$

$$\Rightarrow \boxed{\frac{\Phi_s}{2} = 10.3075 \frac{d}{\lambda_{vac}}}$$

$$\boxed{F_s} = \frac{4\sqrt{0.26526 \times 0.063}}{\left(1 - \sqrt{0.26526 \times 0.063}\right)^2} = \cancel{0.392}\ 0.682$$

$$\Rightarrow T_s = \frac{0.908}{1 + \frac{\cancel{0.392}\ 0.682}{\sin^2\left(10.3075 \frac{d}{\lambda_{vac}}\right)}}$$

* R_s^{max} is when T_s min:

$$T_s^{min} = \frac{0.908}{1 + 0.682} = 0.5398$$

$$\boxed{R_s^{max}} = 1 - T_s^{min} = 0.4602 = 46.02\%$$

This is when: $\sin^2\left(10.3075 \frac{d}{\lambda_{vac}}\right) = 0$

$$\Rightarrow 10.3045 \frac{d}{\lambda_{vac}} = m\pi \quad ; (\lambda_{vac} = 633\,nm)\ (m \text{ is integer})$$

$$\boxed{d} = \frac{\pi \lambda_{vac}}{10.3045} m = 192.986\ nm \quad (\text{with taking } m = 1)$$

↓ smallest ~~integer~~ of

P.4.8 $R = 0.9$, $T = 0.05$, $A = 0.05$, $d = 0.5\ cm$, $n_1 = 1$, $\lambda = 587\ nm$ (normal incident)

[a] $T^{max} = \frac{T^2}{(1-R)^2} = \frac{(0.05)^2}{(1-0.9)^2} = 0.25$

$T^{min} = \frac{T^{max}}{1+F} = 6.925 \times 10^{-4}$

$F = \frac{4R}{(1-R)^2} = \frac{4 \times 0.9}{(1-0.9)^2} = 360$

[b] $\Delta\lambda_{FSR} = \frac{\lambda_{vac}^2}{2 n_1 d \cos\theta_1}$

$= \frac{(587\ nm)^2}{2 \times 0.5 \times 10^{-2} \cos 0}$

$= 3.446 \times 10^{-11}\ m$

$= 0.3446 \times 10^{-10}\ m$

$= 0.03446\ nm$

[c] $RP = \frac{\lambda_{vac}}{\Delta\lambda_{FWHM}}$ ~~$\Rightarrow \frac{587\ nm}{0.1156\ nm} = 5077.785$~~

$\Delta\lambda_{FWHM} = \frac{\Delta\lambda_{FSR}}{f}$

$f = \frac{\pi}{2}\sqrt{F} = \frac{\pi}{2}\sqrt{360} = 29.8$

$\Delta\lambda_{FWHM} = \frac{0.3446 \times 10^{-10}}{29.8}$

$= 1.156 \times 10^{-12}\ m$

$\Rightarrow RP = \frac{587 \times 10^{-9}}{1.156 \times 10^{-12}}$

$= 507,785.5$

P 4.9 $T^{max} = 1$, $F = 10$, $\lambda_{vac} = 633\ nm$, $d = 1\ cm$, $n_1 = 1$

$T^{tot} = \frac{T^{max}}{1 + F_s \sin^2\left(\frac{\Phi}{2}\right)}$

$\Phi = \frac{4\pi n_1 d}{\lambda_{vac}} \cos\theta_1$

$= 198.52 \times 10^3 \cos\theta_1$

$\Rightarrow \frac{\Phi}{2} = 99.26 \times 10^3 \cos\theta_1$

$\Rightarrow T^{tot} = \frac{1}{1 + 10 \sin^2(99.26 \times 10^3 \cos\theta_1)}$

↳ Plot T^{tot} vs θ_1