Problem 1

$d = \frac{m\lambda L}{a}$. We know that $\lambda_0 = 780\text{ nm}$, so $d = \frac{\lambda_0 L}{a} = \frac{2\lambda L}{a}$.

Therefore, $\lambda_0 = 2\lambda \rightarrow 780 = 2\lambda \rightarrow \lambda = 390\text{ nm}$

Problem 2

We are told that $\lambda_0 = 488\text{ nm}$, and there's 12 fringes/cm.

Our equation for destructive interference is: $nd\cos\theta_t = 2m\frac{\lambda_0}{4}$

Since $d = 0.01\cdot\sin\theta$, we have:

$1.34\cdot 0.01\cdot\sin\theta = 6\cdot(488\cdot 10^{-9}) \rightarrow \theta = 0.0125°$ or $2.18\cdot 10^{-4}$ rad

Problem 3

We are told $n = 1.48$ at $20°C$, and varies by $2.5\cdot 10^{-5}$ per degree C.

We also know the coeff. of the linear expansion off the glass.

$\therefore$ n is given by $(2.5\cdot 10^{-5})\,dT + 1.48$.

Now, $l_0 = 0.03$ m. With time, $l = l_0 + (8\cdot 10^{-6})\,l_0\,dT$, where $dT = T - 20$, in Celsius.

Also, the rate of change in T is $\frac{dT}{dt} = \frac{5°C}{1\text{min}}$, and $\lambda_0 = 589\text{ nm}$.

To find how many fringes cross per minute:

$\Delta\phi = m2\pi = \Delta\frac{2\pi}{\lambda}n(T)\cdot 2L(T)$, so $m = \Delta\frac{2}{\lambda}n(T)L(T)$. Now, we plug in:

$m = \frac{2}{\lambda}\left(n(25)L(25) - n(20)L(20)\right)$. Using the values above,

we find $m = 16.5$ fringes

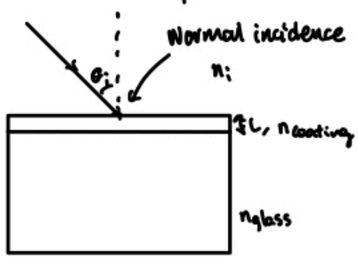
Problem 4

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\delta$. Since $I_1 = 2I_2$, $I = 3I_2 + 2\sqrt{2I_2^2}\cos\delta$,

so $I = 3I_2 + 2\sqrt{2}I_2\cos\delta$

Problem 5

We have $\theta_i = \frac{\pi}{4}$ rad, $n_{glass} = 1.52$, $n_{coating} = 1.37$, $n_i = 1$, and $\lambda_0 = 550\text{nm}$



We have:

$n_i\sin\theta_i = n_c\sin\theta_c \rightarrow \sin\theta_c = \frac{n_i}{n_c}\sin\theta_i$

$\therefore \cos\theta_c = \sqrt{1-\sin^2\theta_c}$.

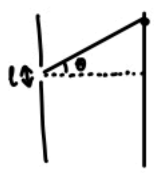
We know that $\Delta\phi = \frac{4\pi n_c}{\lambda_0}l\cos\theta_c$.

Since we want $\Delta\phi = 2\pi$, we have the eq. for l:

$l = \frac{2\pi\lambda_0}{4\pi n_c}\frac{1}{\cos\theta_c} \rightarrow l = \frac{\lambda_0}{n_c}\cdot\frac{1}{\sqrt{1-\sin^2\theta_c}}$

By plugging in n_c and n_i, and λ_0, we find $l = 117.2\text{ nm}$

Problem 6



$\theta = 6.2°$, $\lambda = 1152.2\text{ nm}$.

To find l, the width of the slit, we have:

$\beta = \frac{kl\sin\theta}{2} = m\pi$. Since $k = \frac{2\pi}{\lambda}$, $m = \frac{l\sin\theta}{\lambda}$

Now, we plug in: $l = \frac{m\lambda}{\sin\theta} = \frac{10\cdot(1152.2\cdot 10^{-9})}{\sin(6.2°)} = 1.07\cdot 10^{-4}\text{m}$

If we let $n = 1.33$, the only thing that changes is λ:

$\lambda' = \frac{\lambda}{n} = 866.3\text{ nm}$, so $\sin\theta' = \frac{\lambda m}{l} \rightarrow \theta' = \sin^{-1}\left(\frac{866.3\cdot 10^{-9}\cdot 10}{1.07\cdot 10^{-4}}\right) = 4.66°$