Optics Questions

Part 1

a) A Fabry-Perot etalon consists of a single piece of glass of index of refraction *n*. Its two flat and parallel surfaces are coated with a dielectric mirror with intensity reflectivity R. *Derive* a simple expression for the phase shift between the incident and transmitted field amplitudes in this etalon as a function of δ, where $\delta = 4\pi n\ell\cos(\theta)/\lambda$, n is the index of refraction of the etalon material, ℓ is the thickness of the etalon, θ is the angle of incidence, and λ is the wavelength of light. Note: You must derive your expression from fundamental principles and express it in simplest form to receive full credit. (2 pts)

b) Show that for small variations around $\delta = 2\pi m$ (m is an integer), the phase of the transmitted light is *linearly* related to δ. What is the constant of proportionality? (1 pt)

Part 2

Consider using an etalon as a spectral filter. The filter is to be tuned to a specific fixed wavelength of 1 μm by adjusting its temperature so that the etalon thickness produces a high transmittance at the desired wavelength. The light is normally incident on the etalon ($\theta = 0$). The etalon glass has an index of refraction n = 1.5 and a thickness of $\ell = 2$ cm. The reflectivity of the coatings on each side is selected to produce a spectral resolution of 100 MHz. A mechanical engineer must ensure that a thickness change (produced by a temperature drift) does not cause the etalon to shift in resonance by more than its spectral resolution (100 MHz). Calculate the allowable thickness change. (1 pt)