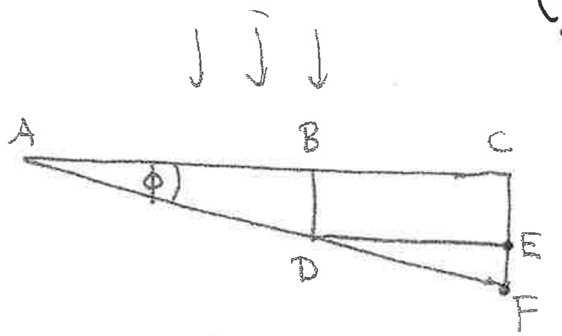
ASG vol 3 EX 21.1
(soap film interference)



Blue fringe @ B.
Red fringe @ C.
$\overline{BC} = 80\,\mu m$.

1) Basic idea: a blue fringe appears @ B because the light reflecting off the soap @ position B is intefering constructively with the light reflecting off the (bottom of) the soap film @ position D. This, latter, light wave must have advanced through one entire wavelength as a result of traveling from B to D, reflecting at D, and going back from D to B. The reflection at D causes a $\frac{1}{2}\lambda$ phase shift, since it is occurring at a surface for which the index of refraction, n_{air}, is smaller than that for the soap, n_{soap}. The other $\frac{1}{2}\lambda$ is created by travelling $B \to D$ and $D \to B$.

So the distance $\overline{BD} = \frac{\lambda_{blue}}{4}$.

Similarly, for the red light. So the distance $\overline{CF} = \frac{\lambda_{red}}{4}$. Moreover, since $\triangle ACF$ and $\triangle DEF$ are similar, $\measuredangle EDF = 0.1$ degrees. So distance $\overline{EF} = \overline{DE} \tan(0.1 \text{ deg}) = \overline{BC} \tan(0.1 \text{deg.})$

So finally, we have that

$$\frac{\lambda_{red}}{4} - \overline{BC} \tan(\phi) = \frac{\lambda_{blue}}{4}$$

Or even

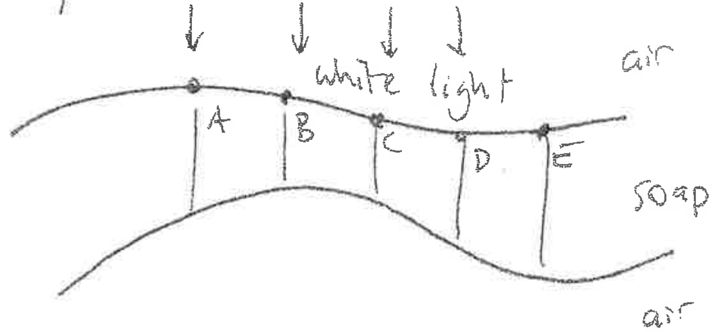
$$\lambda_{red} - \lambda_{blue} = 4(80_{\mu m}) \tan(0.1 \text{ deg})$$

$$\boxed{\lambda_{red} - \lambda_{blue} = 560 \text{ nm}}$$

2) The film is dark (black) where it touches the glass, due to the $\lambda/2$ reflection phase shift at the bottom of the soap film.

3) Soap films exhibit a variety of colors due to variations in thickness, much like the soap film discussed by Young.

For example, in a region where the soap



bubble varies in thickness, from A, to B to C to D to E, you might see different colors since the different thicknesses will cause different colors to experience constructive interference. At A, maybe it looks red, at B, perhaps violet, at C, perhaps green, etc.