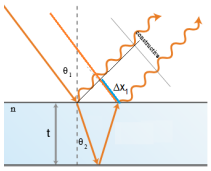
General Physics II Honors (PHYS 102H)

Problem set # 10 *(due May 2)*
All problems are mandatory, unless marked otherwise. Each problem is 10 points.

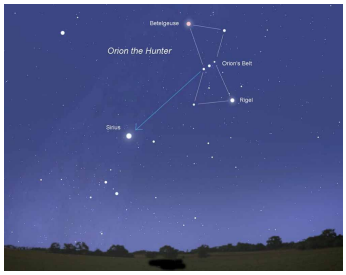
Q1 A red laser ($\lambda = 700$ nm) is used to produce a two-slit interference on a distant screen. Imagine we safely transferred this experiment to operate in water ($n_{water} = 1.33$). Describe all the changes in the interference picture. Will the color of the fringes change?

Q2 When discussing thin film interference in class, we assume normal incidence of light to the field. If the incident beams form angle θ_1 with the normal, as shown, the situation is more complex. In this case both interfering beams have extra distance to travel before they interfere.
a) Show that the extra distance the beam reflected off the back of the film is $\Delta x_2 = 2nt/\sqrt{n^2 - \sin^2\theta_1}$.
b) The beam reflected off the top of the field also have to travel extra distance to compensate the horizontal shift. Show that this distance is $\Delta x_1 = 2t\sin^2\theta_1/\sqrt{n^2 - \sin^2\theta_1}$.
c) Using these distances, show that the condition for observing no reflection for the light with wavelength λ_0 is $2t\sqrt{n^2 - \sin^2\theta_1} = m\lambda_0$, where $m = 0, 1, 2\cdots$ is an integer number.



Q3 The pupil of a human eye is normally around 5 mm in diameter. A person with 20/20 vision should be able to read letters 9 mm high at a distance of 20 m. Elves, on the other hand, while having human-like complexion, have superior vision. In Chapter two of The Two Towers Legolas can resolve objects of around 10 cm size at a distance of five leagues (about 24 km). Comment if, as physicists, we may be a bit skeptical. Feel free suggesting how it may be physically possible.

Q4 Explain what is wrong with the following "logical" construction:
The resolution limit of a normal human eye is about one angular minute $1'$*. We can test this by asking a friend to hold an object, for example, a soccer ball, walk away from us and not at which distance we stop distinguishing the ball. The distance to the star Sirius is 9.7 light years (approx* $9 \cdot 10^{13}$*km), and its diameter is* $2 \cdot 10^6$*km, so that its angular size is 1/13000 of an angular minute. Thus, we should not be able to see Sirius with naked eyes.*
Sirius is the brightest start in our sky (apparently, one can even distinguish it even at daylight), so something is wrong with this argument.



$$e = 1 - \frac{1}{\gamma}\frac{T_D - T_A}{T_C - T_B}$$