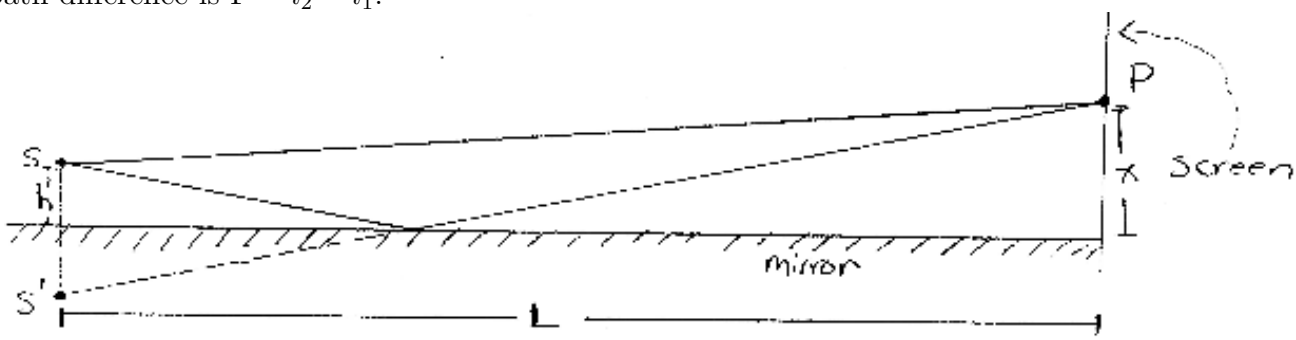
Physics 2P51 Assignment 4

Due: Tuesday, March 26, 2019.

1. (a) **Based on Textbook problem 12-8**. The diameter of the fourth bright Newton ring is 10.0 mm. When an unknown liquid is poured into the gap between the lens and support, the diameter of this ring shrinks to 8.45 mm. Calculate the liquid's index. Assume lens and support are made of the same material and that the observations are made in reflection. Is the center fringe bright or dark?

   (b) Assume that the lens is made of flint glass of index 1.72, and that the support is made of crown glass of index 1.52. Oil of index 1.65 is poured into the gap. What is the diameter of the fourth bright ring observed in reflection? Is the center fringe bright or dark?

2. In a Lloyd's mirror experiment a source, S, is placed a small height, h, above a mirror and a detection screen is placed a much greater distance, L, away. Each wave from the source is partly reflected, and partly traverses straight to the observation point, P, where the wave recombines and interference fringes are observed. Point P is a height, x, above the surface of the mirror. The reflected part of the wave may be considered as originating at S′, the mirror image of the source point, as shown in the figure below. If the distance from S to P is l_1, and that from S′ to P is l_2, then the path difference is $\Gamma = l_2 - l_1$.



   (a) Find an exact expression for x in terms of L, h, and Γ. (The relation $l_2^2 - l_1^2 = (l_2 - l_1)(l_2 + l_1) = \Gamma(2l_1 + \Gamma)$ may be helpful).

   (b) Will the fringe at x=0 be bright or dark? Explain.

   (c) Show that for L≫h≫ Γ the result of (a) reduces to $\Gamma \approx \frac{2hx}{L}$. Use this to determine how high above the surface of the mirror the third *maximum* will be detected in an experiment using light of wavelength 633 nm, with h=1.0 cm and L=2.0 m.

3. A continuous He-Ne laser beam (632.8 nm) is 'chopped' using a spinning aperture into 0.10 ns pulses. Calculate the resultant line width, $\Delta\lambda$, bandwidth, Δf, and coherence length.