Physics 223

FINAL EXAM 25 June 1996

I -- In a Young's experiment the incident light is monochromatic and linearly polarized normal to plane of incidence (page), see Fig. 1.

1. a) Give a general expression for the interference intensity I in terms of amplitudes a_1, a_2 and phase difference δ.

   b) Find the conditions for maxima and minima of I.

   c) Find an expression for the position y of the mth fringe.

   d) Answer (c) if a glass plate of thickness t and index n covers slit S_1.

   e) Deduce the fringe spacing i in(c) and (d) .

2. Find the effect on the central fringe and fringe spacing i if :

   a) glass plate in (d) changes optical path by $\lambda/2$

   b) the whole apparatus is immersed in liquid of index $n_l = 2$

   c) slit S_1 is covered by a crystalline $\lambda/2$-plate whose axes make 45° with page

   d) the light source is polychromatic.

   e) the light source is off-axis

3. If slit S_1 is twice as wide as S_2, find :

   a) I_{max} and I_{min} in terms of a_2 and δ

   b) the visibility of the fringes

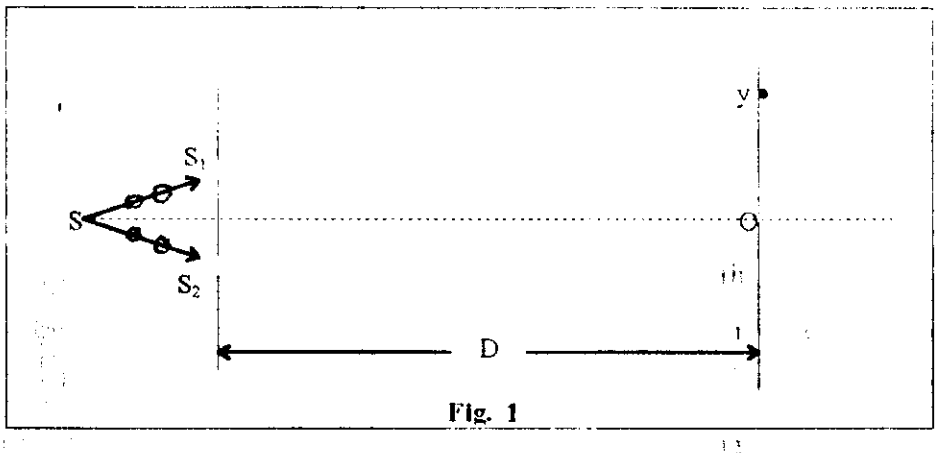

Fig. 1

II -- Natural light is incident at angle i on a plane parallel plate of glass of index n = 1.53 (see Fig. 2)

1. If i = 52.0°, find the degree of polarization V of the first reflected ray R_1
2. If the reflected light is completely linearly polarized find:

a) angle of incidence i

b) V of 1st transmitted ray T_1

c) V of 2nd transmitted ray T_2

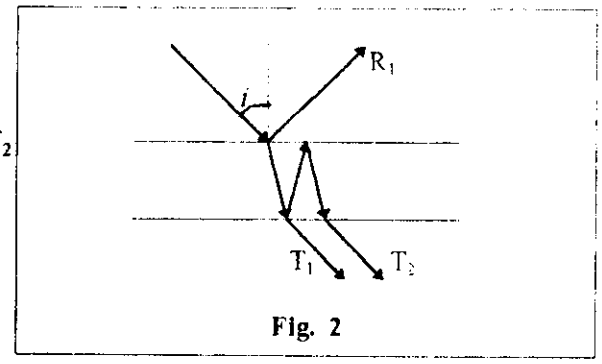

Fig. 2

III -- Consider a crystalline prism C (n_o = 1.544, n_e = 1.553) joined along the diagonal to a glass prism G of the same angle θ and of index n (see Fig. 3).

1. Using Huygens' construction, trace the path of the refracted rays with vibration direction in prism C, prism G and in air if :

a) n = n_o

b) n_o < (n = 1.55) < n_e

2. Find the angular separation of the emerging rays in (a) and (b) if θ = 30.0° .

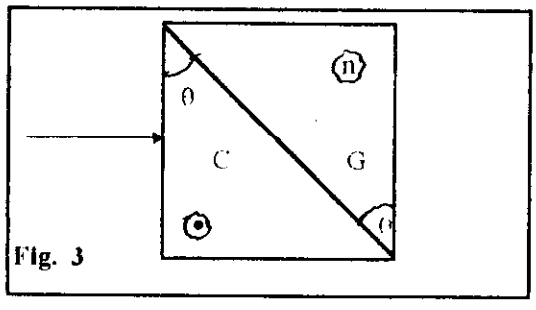

Fig. 3

$$r_{\perp} = \frac{n_1 \cos i - n_2 \cos r}{n_1 \cos i + n_2 \cos r}; r_{\Pi} = \frac{n_2 \cos i - n_1 \cos r}{n_2 \cos i + n_1 \cos r}; t_{\perp} = \frac{2n_1 \cos i}{n_1 \cos i + n_2 \cos r}; t_{\Pi} = \frac{2n_1 \cos i}{n_1 \cos r + n_2 \cos i}$$

$$r_{\perp} = -\frac{\sin(i-r)}{\sin(i+r)}; \quad r_{\parallel} = \frac{\tan(i-r)}{\tan(i+r)}; \quad t_{\perp} = \frac{2 \sin r \cos i}{\sin(i+r)}; \quad t_{\parallel} = \frac{2 \sin r \cos i}{\sin(i+r)\cos(i-r)}$$