8. A Newton's rings experiment is performed with oil of index n = 1.65 between the two surfaces and is observed in reflection. Assume an index of glass of n = 1.50. Green light of wavelength 520 nm is incident normally. The radius of curvature of the curved surface is 100.0 cm.
(a) Is the center spot light or dark?
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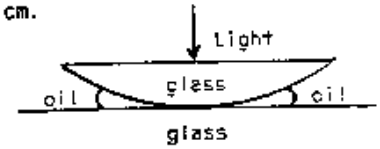

Spring 82

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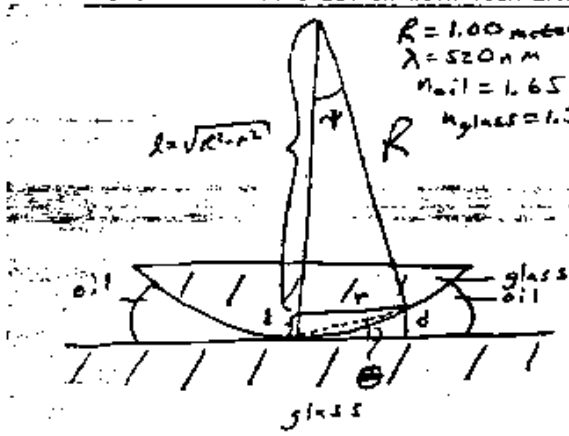
Note that the interference effects are in oil film and not the glass. (see Halliday & Resnick pg 739 problem 43)



A) There is a glass to oil interface which means (since $n_{oil} > n_{glass}$) the minima are given by

$$m\lambda = 2n_{oil}d$$

at the center $m = 0$, $d = 0$. 5pts

There is a dark spot at the center (or minimum).

B) The fifth dark fringe occurs at $m = 4$ since you start counting the 1st one at $m = 0$. 4pts

Thus $m\lambda = 2n_{oil}d$ (thin film diff eqn) 4pts for eqn

$$d = \frac{2\lambda}{n_{oil}} = 6.30 \times 10^{-7}\ m$$

where d is the thickness of the film of oil 4pts. (need to say what d is explicitly)

r is the radius from the center of the glass piece to the ring of interest. (see figure)

The triangle (sides h, R, r) is the basic geometry. Note that angle ψ is not equal to angle θ

8 pts for r (the radius)

one solution for r:

$d = R - h$

$d = R - \sqrt{R^2 - r^2}$

$\sqrt{R^2 - r^2} = R - d$

$R^2 - r^2 = (R-d)^2$

$r^2 = R^2 - (R-d)^2$

$r = \sqrt{R^2 - (R-d)^2}$

$r = \sqrt{2Rd - d^2}$

$r = 1.12 \times 10^{-3}\ m$

omission of the 2 or n (-3pts)

Another solution: $d = R - h$

$\cos\psi = \frac{h}{R} = \frac{R-d}{R}$

$\psi = \cos^{-1}\frac{R-d}{R}$

$\sin\psi = \frac{r}{R}$ $r = R\sin\psi$

also: $d = R - R\cos\psi$ ... etc

1 - 4 pts given for right head. Rest: algebra, calc's etc

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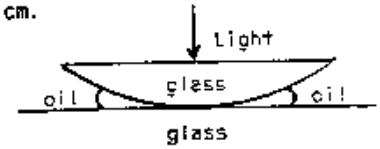

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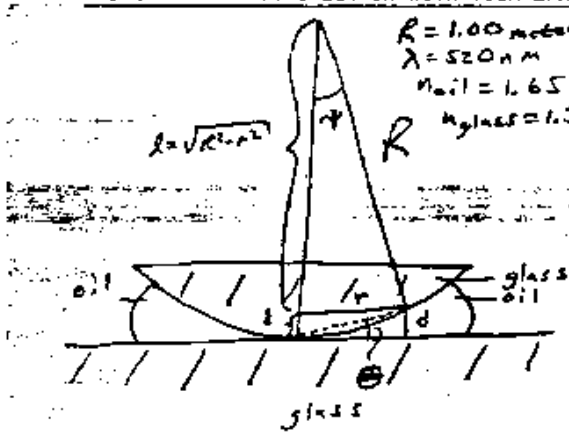

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