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?

(b) Find the radius of the fifth dark fringe. (If the center is dark, count it as one.)

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$R = \frac{1}{60}$ meters
$
\lambda = 520$ nm

$\text{ra}_{\text{oil}} = 1.65$
$\text{ra}_{\text{glass}} = 1.50$

$b = \sqrt{R^2 - (m \lambda)^2}$

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The fifth dark fringe occurs at $\text{m} = 4$ since you start counting the 1st one at $n = 0$.

Thus $m\lambda = 2n_\text{oil}d$ (minimum dark)

$d = \frac{2\lambda}{m_\text{oil}} = 6.30 \times 10^{-3}$ m

where $d$ is the thickness of the oil film.

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$r$ is the radius from the center of the glass piece to the ring of interest.

(see diagram c)

The triangle (sides $l, r, r$) is the key geometry. Note that angle $l$ is not equal to angle $r$.

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Please turn this sheet in with your exam.

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Note that the interference effects are in oil (n=1.65) and not the glass. (See Haldane's Fresnel.)

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

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

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

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

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Another solution: $d = R - r$

$\cos \theta = \frac{R - r}{R}$

$r = \frac{\text{ra}_{\text{oil}} - \text{ra}_{\text{glass}}}{2}$

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Please note: $d = \text{ra}_{\text{oil}} - \text{ra}_{\text{glass}}$ etc.
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?

(b) Find the radius of the fifth dark fringe. (If the center is dark, count it as one.)

\[ R = 1.00 \text{ meters} \]
\[ \lambda = 520 \text{ nm} \]
\[ m = 1.65 \]
\[ n_{oil} = 1.65 \]
\[ n_{glass} = 1.30 \]

\[ R = \sqrt{\frac{2m \lambda d}{n_{oil}}} \]

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

Thus \( m \lambda = 2n_{oil} d \) (middle dark)

\[ d = \frac{2 \lambda}{n_{oil}} = 6.30 \times 10^{-5} \text{ m} \]

where \( d \) is the thickness of the film of oil.

\[ d = \frac{1}{2} \left( \frac{1}{n_{oil}} - \frac{1}{n_{glass}} \right) \]

\[ R = \sqrt{\frac{2m \lambda d}{n_{oil}}} \]

This is the radius from the center of the glass piece to the ring of interest.

(see figure 2c)

The triangle (sides \( 2d, 2r, R \)) is not right, hence angle \( \theta \) is not equal to angle \( 8 \text{ pts for } \theta \) (the radius).

\[ d = (R - \sqrt{R^2 - R^2 \cos^2 \theta}) \]

\[ r = R \sin \theta \]

\[ \cos \theta = \frac{R - d}{R} \]

\[ R = \frac{R^2}{R - d} \]

\[ \sin \theta = \frac{d}{R - d} \]

\[ \theta = \sin^{-1} \left( \frac{d}{R - d} \right) \]

8 pts