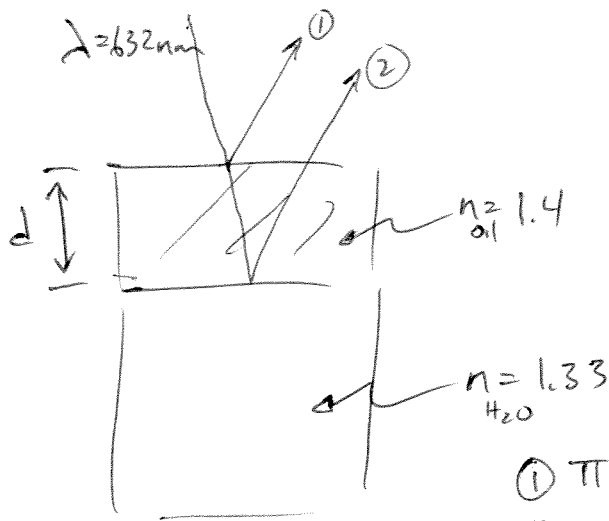


General Problem Solving Guide

List given information, define variables, sketch picture:

Name: KEY
 Lab Time:
 Date: EXAM 2
 Test Code:
 Problem #: 21

3pt



* Assume normal incident light.

Thin Film Interference

- ① π phase shift ($n_{air} < n_{oil}$)
- ② 0 phase shift (boundary has $n_{oil} > n_{H_2O}$)

Simplify question, list target quantity:

1/2 pt

Find minimum thickness of oil for constructive interference

List all related quantitative relationships:

$$\phi_1 = \phi_2 - 2\pi m \quad (m \text{ is number of phase shifts})$$

2pt

$$\phi = \phi_0 + \frac{2\pi}{\lambda} x$$

$$v = \lambda f \quad \text{in vacuum (air)}$$

$$c = \lambda f$$

$$x = 2d$$

$$\lambda = \frac{\lambda_0}{n} \quad v = \frac{c}{n} = \frac{\lambda_0}{n} f$$

Outline approach, sketch diagrams if needed (or sketch next to pictures above):

1/2 pt

- Equate phases at surface (air-oil boundary)
- Wavelength decreases - which effects phase shift - as light enters oil from air
- $m = 0$ for minimum phase shifts = minimum distance
- Solve for thickness

Obtain a general solution:

$$\phi_1 = \phi_2 = 2\pi m \quad (m=0)$$

$$\phi_1 = \pi$$

$$\phi_2 = 0 + \frac{2\pi}{\lambda} x \quad (x=2d)$$

$$\pi = \frac{2\pi}{\lambda} (2d) \quad (d = \frac{\lambda_0}{n})$$

$$\pi = \frac{2\pi}{\lambda_0} n (2d)$$

solve for d

$$d = \frac{\lambda_0}{4n}$$

PARABOLIC MENSURUS

As d increases the phase difference changes.

You start out w/ constructive interference and when d increases by $\frac{\lambda_0}{4}$ you will see deconstructive interference.

Hence light and dark bands are seen - with band thickness decreasing (parabolic thickness equation)

Check Units:

$$nm = nm$$

1 pt

Check Limiting Cases:

$$\lambda_0 \uparrow \quad d \uparrow$$

✓ need longer distance to change phase

$$n \uparrow \quad d \downarrow$$

✓ smaller d in material

$$m \uparrow \quad d \uparrow$$

✓ (note) phase change adds $\frac{1}{2}\lambda$ thickness

1 pt

Obtain a numeric solution:

(i.e. plug in the numbers)

$$d = 113 \text{ nm}$$

$\frac{1}{2}$ pt

Why is solution reasonable? Explain.

- units check
- limiting cases make sense
- answer seems reasonable (it is a thin film)

1 pt