PhysicsTutor

mh

Interference

Knight 21.23

Problem:

- What is the thinnest film of MgF_2 (n=1.39) on glass that produces a strong reflection for orange light with a wavelength of 600 nm?

Relevant ideas:

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- Watch out for phase jumps when light reflects from the air-film, and film-glass interfaces.
- Find the lowest-order interference. Watch out for the optical path length as opposed to physical path length.

Equations associated with ideas:

$$E(x,t) = E_0 \sin\left(\omega t - \frac{2\pi}{\lambda_{med}} x + \phi\right) \; ; \; \lambda_{med} = \frac{\lambda_{vac}}{n}$$

2 light paths at same t, x : phase difference

$$\Delta\phi = \phi_2 - \phi_1 = \frac{2\pi}{\lambda_{med}} \Delta x = \frac{2\pi}{\lambda_{vac}} \underbrace{n \, \Delta x}_{\text{optical path length differences}}$$

physical path length

$$\Delta\phi = 2\pi m \qquad m = 1, 2, 3, \dots$$

constructive interference

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- Realize that both waves undergo phase jumps upon reflection, so we can ignore them.
- Same arrival time for both paths: find the accumulated phase difference (PD) in space from the optical path length difference.
- Constructive interference: PD=multiple of 2π.

Solution

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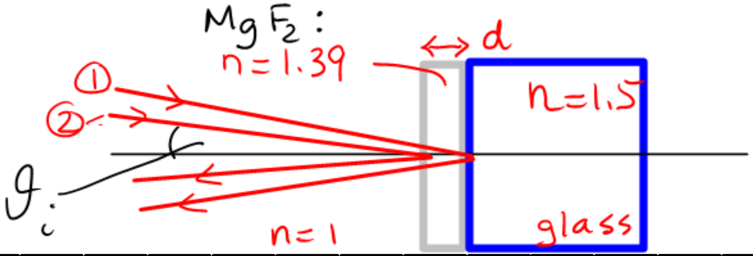
- 

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for $\vartheta_i \approx 0$ $\cos\vartheta_i \approx 1$

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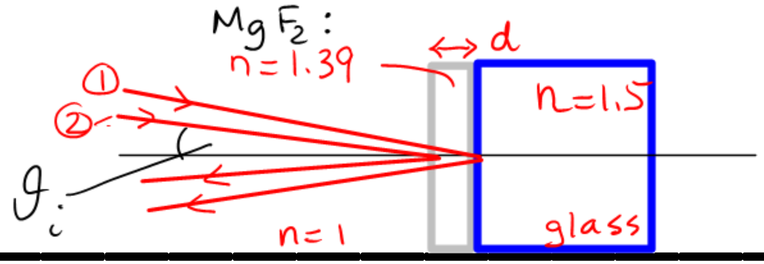
- 

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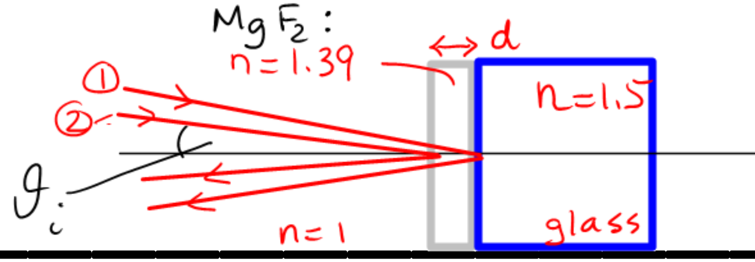
- 

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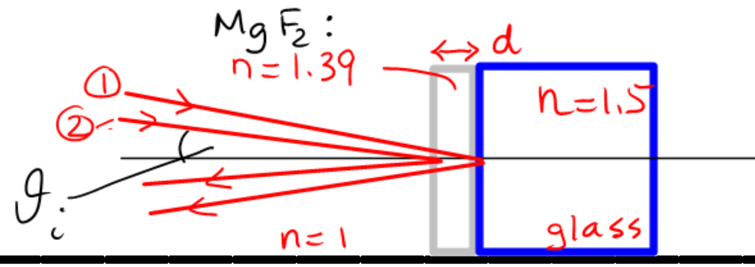
- 

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- $\therefore\ d = \frac{\lambda}{2n} = \frac{600}{2 \cdot 1.39}\,\text{nm} = 216\ \text{nm}$

what happens to transmission (at near-normal) incidence at this wavelength ? destructive interference.

Q: is the picture used too simple ? (probably) reflections + refractions occur!