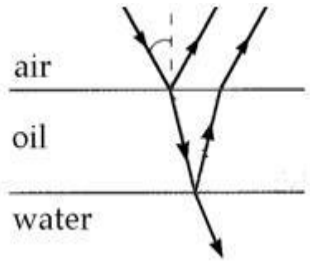
Answer on Question #50690, Physics, Optics

An oil (μ_0 = 1.45) film of thickness 280 nm floats on water (μ_w = 1.33). It is illuminated by white light at normal incidence. Which colour in the visible spectrum will be most strongly (i) reflected, and (ii) transmitted?

Solution:



Since 1<1.45, the light reflected from the top of the oil film undergoes phase reversal. The light reflected from the bottom undergoes no reversal because 1.45>1.33.

(i) For constructive interference, we require

$$2\mu_0 d = (m + \frac{1}{2})\lambda$$

Substituting for m gives, m=0, λ_0=1624 nm (infrared)

m=1, λ_1=541 nm (green)

m=2, λ_2=325 nm (ultraviolet)

Both infrared and ultraviolet light are invisible to human eye, so the dominant color in reflected light is **green**.

(ii) transmitted

For destructive interference – Transmission

$$2\mu_0 d = m\lambda$$

Substituting for m gives, m=1, λ_1=812 nm (near infrared)

m=2, λ_2=406 nm (violet)

m=3, λ_3=271 nm (ultraviolet)

The dominant color visible to human eye is **violet**.

Therefore the color of the light in the visible spectrum most strongly transmitted is **violet.**

a. Since we are talking about waves that are the most strongly reflected then we have constructive interference, we have: $2tn_{oil} = \left(m + \frac{1}{2}\right)\lambda$

Therefore: $\lambda = \frac{2tn}{m + \frac{1}{2}} = \frac{2 \times 280\,nm \times 1.45}{m + \frac{1}{2}}$.

For $m = 0$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{\frac{1}{2}} = 1620\,nm$ (infrared – invisible)

For $m = 1$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{1 + \frac{1}{2}} = 542\,nm$ (green – visible)

For $m = 2$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{2 + \frac{1}{2}} = 325nm$ (ultraviolet – invisible)

Therefore the color of the light in the visible spectrum most strongly reflected is green.

b. Since we are talking about waves that are the most transmitted then we have destructive interference, we have: $2tn_{oil} = m\lambda$

Therefore: $\lambda = \frac{2tn}{m} = \frac{2 \times 280\,nm \times 1.45}{m}$.

For $m = 1$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{1} = 812\,nm$ (infrared – invisible)

For $m = 1$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{2} = 406\,nm$ (violet – visible)

For $m = 2$, $\lambda = \frac{2 \times 280\,nm \times 1.45}{3} = 271nm$ (ultraviolet – invisible)

Therefore the color of the light in the visible spectrum most strongly transmitted is violet.